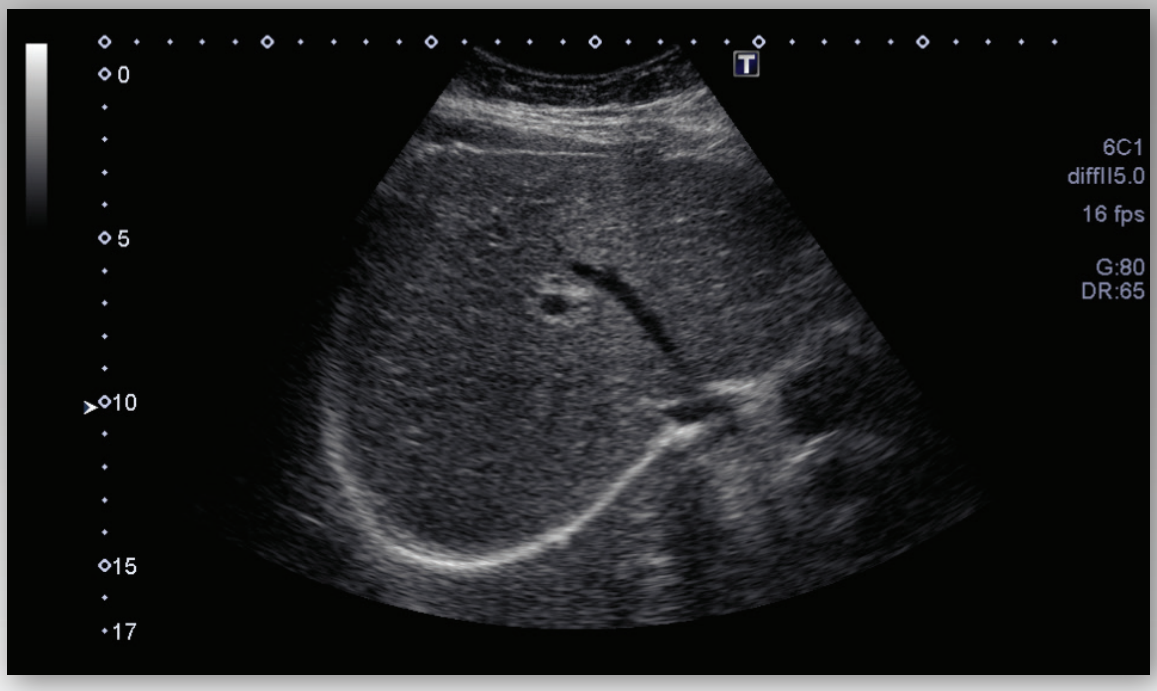
Canon

UL White Paper

More Depth. More Detail.

Next Generation D-THI



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Adequate visualization is a fundamental prerequisite for accurate diagnostic interpretation of any imaging study. However, with the increasing prevalence of obesity, the recurring phrase "limited secondary to body habitus" has become the hallmark of subjective diagnoses when using ultrasound. Modality ineffectiveness is often attributed to the balanced struggle between resolution and tissue penetration. There exists an overall demand for technological improvements aimed at combating this dilemma. In response to this demand, Canon Medical Systems Corporation has developed Differential Tissue Harmonic Imaging II (D-THI II), a novel imaging mode aiming to extend the blurred boundary of tissue penetration.

The World Health Organization (WHO) estimates that more than 1.9 billion people worldwide are overweight, of which over 600 million are classified as obese (defined by WHO as having a body mass index (BMI) greater than or equal to 30). The condition has rapidly become a global crisis demanding the need for specialized equipment. Radiology, specifically sonography which is often performed as an initial evaluation, faces a multitude of technical challenges when imaging obese patients. The detrimental reduction of image quality and an inability to effectively visualize structures located at deeper depths are two of the most frequently encountered obstacles. The innovative second generation D-THI II, available on Canon Medical Systems' Aplio™ Platinum Series ultrasound systems, was designed to increase the generation of nonlinear signals at greater depths, with subsequent improvement in penetration of the sound beam (Figure 1).

D-THI II is a nonlinear imaging technique that differs from traditional harmonic modes by transmitting a dual-frequency pulse. The received echoes include components (sums and differences) of the two transmitted pulses, as well as their harmonic responses (Figure 2). Similar to the first generation D-THI, D-THI II results in improved resolution at greater ranges of depth (>10 cm) which is demonstrated in Figure 3. D-THI II uses an enhanced frequency-matching technique to maximize the full bandwidth of the transducer, which results in better spatial resolution, uniformity, and near field image quality when compared with standard B-mode or THI imaging.

Our research team at Thomas Jefferson University has performed a comparative study to assess the efficacy of D-THI II for clarifying structures located at depths of ≥ 10 cm. The prospective clinical trial was approved by the university's Institutional Review Board (IRB) and included patients with confirmed liver and/or renal pathology who possessed a calculated BMI of 30 or above. Still images were acquired using the 6 MHz curvilinear probe. Target regions of interest were localized and scanned. The selected areas were imaged

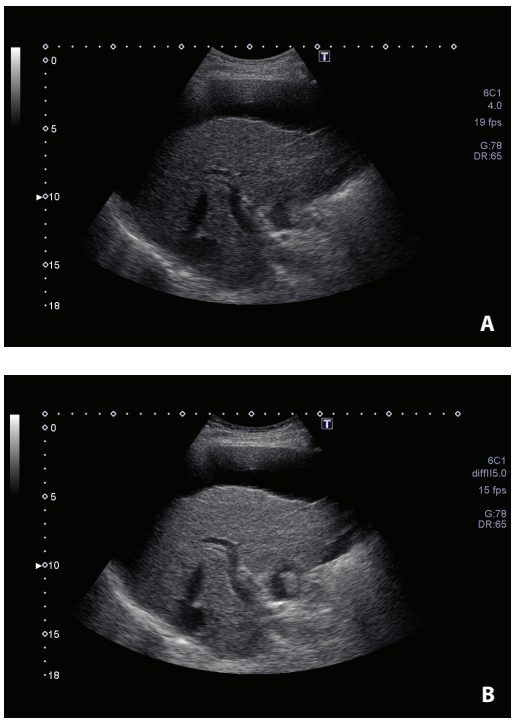

Figure 1: Sagittal scans of a right liver lobe in a cirrhotic patient with a calculated BMI of 33. The liver extends to a depth of 17 cm and is demonstrated using the A. fundamental grayscale, and B. D-THI II modes.

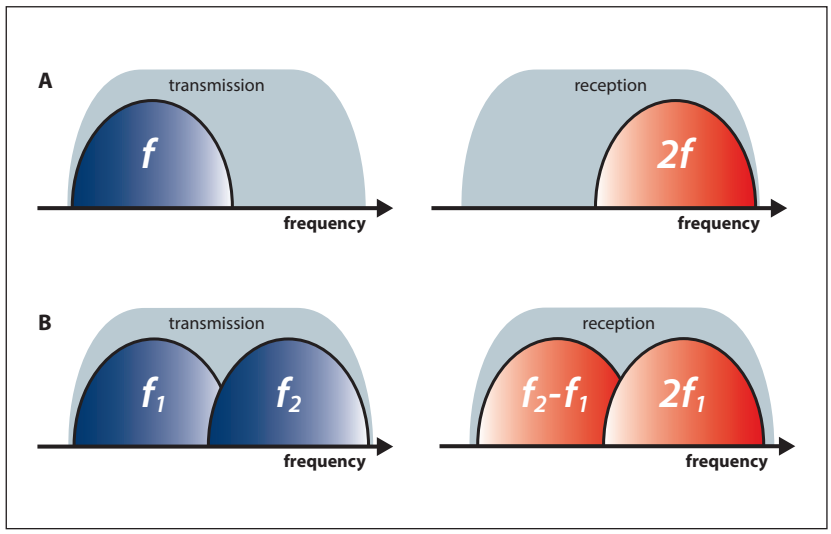

Figure 2: Comparative principles of A. traditional harmonic imaging and B. D-THI II.

using fundamental grayscale (transmit frequency of 4 MHz), traditional tissue harmonic imaging (THI), and D-THI II modes (transmit frequencies of 5 MHz). Fixed imaging parameters (overall gain, focus, and dynamic range) were engaged for each scan. In addition, image compounding (i.e. ApliPure™) and advanced image processing (i.e. Precision imaging) features were disabled to enable the direct comparison of the fundamental, THI, and D-THI II imaging modes. A sequential comparison by 3 independent and blinded observers (radiologist, sonographer, and physicist), of each imaging set (images obtained with all three modes at the same anatomic location) was conducted. The observers had varying levels of sonography expertise, ranging between two to 30 years. All of the images were edited to conceal the fixed parameters and modes from each reader. All three modes were scored with a visual analog scale (VAS) ranking of one (best) to seven (worst). Each imaging technique was ranked on detail resolution, image quality, margin delineation, and depth of penetration.

Although the study is ongoing, initial results in this application are encouraging. For all parameters assessed, D-THI II outperformed THI and fundamental grayscale (Table 1). D-THI II achieved the highest scores for detail resolution and depth of penetration, thus providing supporting evidence of technique design. The study further confirmed Canon Medical Systems' THI and D-THI II modes were significantly better than fundamental grayscale with respect to detail resolution, image quality, margin delineation, and depth of penetration.

New technological advancements in ultrasound should assist in clinical diagnosis and facilitate image acquisition. D-THI II succeeds in coupling both of these feats by improving the harmonic environment at deeper depths. D-THI II's ability to produce high quality images, irrespective of body habitus, is a unique achievement that will enrich diagnostic confidence. The potential benefit of this improved nonlinear technique may have a lasting legacy.

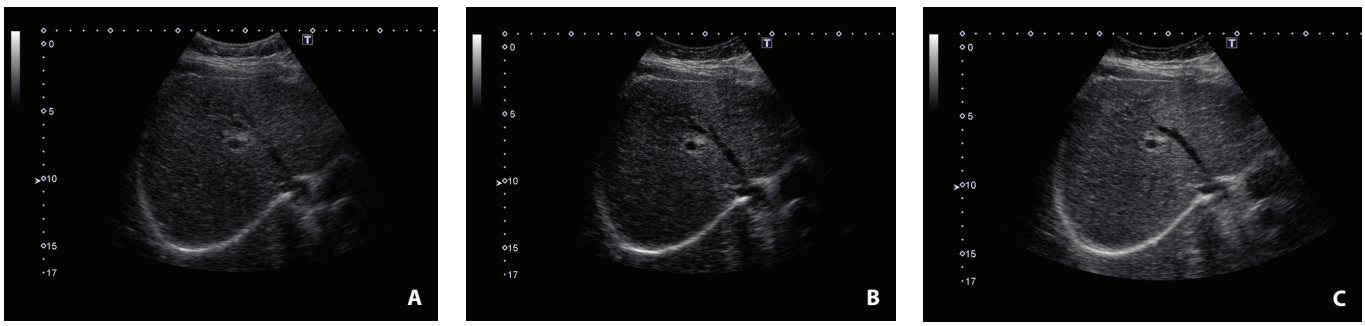

Figure 3: Examples of comparison images utilized in the table below. A. fundamental grayscale, B. THI, and C. D-THI II.

Parameter	Fundamental Grayscale	THI	D-THI II
Detail Resolution	4.7	2.0	1.6
Image Quality	4.2	1.9	1.8
Margin of Delineation	4.4	2.2	1.9
Depth of Penetration	4.0	2.2	1.6

Table 1: Average score of parameters assessed for each imaging mode on a scale of one (best) to seven (worst).

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