

Clarify Vascular Enhancement Technology

*Rodney Boleyn, M.S.; Qinglin Ma, Ph.D. and Tommy Wong
Engineering Department
Ultrasound Division
Siemens Medical Solutions USA, Inc.*

Introduction

While advances in medical ultrasound imaging are typically developed to solve specific clinical or workflow challenges, they can also open new windows of clinical opportunity for greater diagnostic confidence.

For example, B-mode imaging is invaluable in providing tissue information (anatomy). Color flow, power Doppler and spectral Doppler revolutionized ultrasound by revealing blood flow and vascular information (physiology of flow). Typically, when these modes are used in combination, the clinician is presented with a more complete diagnostic picture than that provided by either modality alone.

Today, Clarify™ vascular enhancement technology can optimize the image by enhancing the B-mode display with information derived from power Doppler, clearly differentiating vascular anatomy from acoustic artifacts and surrounding tissue. As a result, Clarify VE technology significantly improves tissue imaging, while minimizing the number of keystrokes necessary to obtain this improved level of performance.

By reducing keystrokes, Clarify VE technology is an exam accelerator, and therefore has the potential to reduce repetitive stress injuries. Clarify VE technology brings a new level of definition and confidence to conventional 2D vascular imaging, enhancing the diagnostic information and providing exceptional workflow.

The Challenges of Conventional Imaging

Clarify VE technology was developed to resolve four specific clinical issues inherent in conventional ultrasound imaging:

1. **Vessels and fetal heart chambers frequently filled with artifacts** generated by partial volume averaging effects due to sound beam slice thickness, thermal noise, grating lobes and multi-reverberations from other highly reflective structures.
2. **Poorly defined boundaries within major vessels** such as the intimal lining, atherosclerotic plaque and thrombus. The partial volume effect, reverberations, grating lobes and thermal noise can obscure pathology and vessel boundaries in a B-mode image.

3. **Poor visualization of small vascular structures in a B-mode image.** Power flow imaging is now the standard method for visualizing flow inside the small vessels within the thyroid, testis and kidney, all of which contain vessels that can be challenging to image in B-mode. The resolution of conventional Power flow mode is inherently poorer than B-mode, so the structure or anatomy of small vessels cannot be visualized as clearly using the Power flow mode only.
4. **Limited contrast resolution in structures with similar echogeneity.** Traditional B-mode imaging often does not show changes in grayscale parenchyma where anatomical regions are differently perfused.

Addressing the Challenges

In practical terms, Clarify VE technology enables an advanced level of tissue/flow differentiation, with the results applied toward enhancement of the B-mode image. Clarify VE technology does so through real-time, pixel-by-pixel analysis using data from both B-mode and flow images in an intelligent, nonlinear way (see Figure 1). Clarify VE technology is adaptive to the strength of the flow signal and is optimized according to various exam types. In nonvascular regions, the B-mode image remains unchanged. Where macro or micro-vascularity is present, Clarify VE technology incorporates information from power Doppler into the B-mode display.

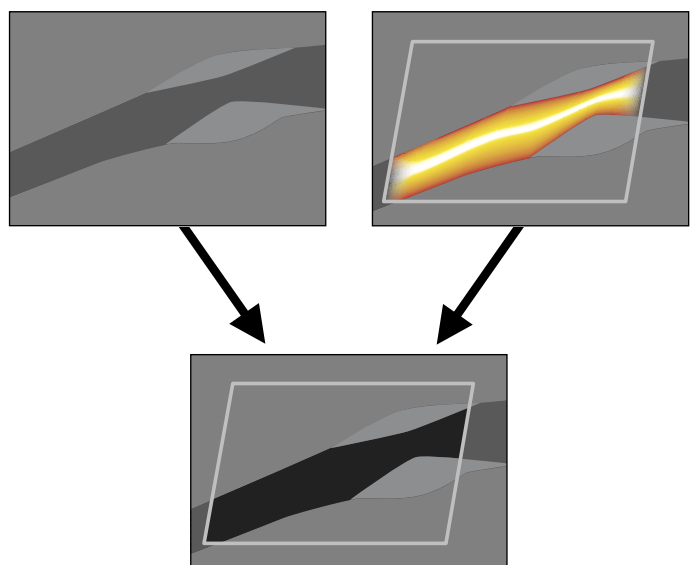


Figure 1. With a unique algorithm that selectively utilizes B-mode and power Doppler information, Clarify VE technology can dramatically improve visualization in both the macro- and microvasculature.

For large vessels, Clarify VE technology is adapted to the strong flows. For example, inside a carotid, noisy B-mode pixel values are suppressed, resulting in a clean flow channel. Normal vessel boundaries or pathologies, such as plaque, are preserved by Clarify VE technology with unobscured and well-defined edges. Regions such as calcified tissues without flow remain unchanged (see Figures 2A, 2B). Clarify VE technology can also aid in the detection of easily missed, hypoechoic soft tissue plaque by clearing clutter within the flow channel.

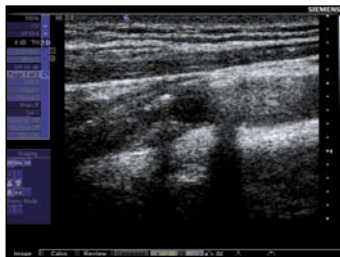


Figure 2A. Conventional imaging

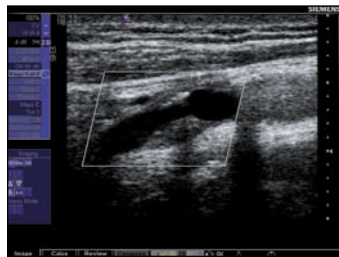


Figure 2B. Clarify VE technology clearly outlines carotid artery plaque

Figure 3B shows improved contrast resolution in a thyroid with Clarify VE technology compared to standard B-mode imaging (Figure 3A). Note the superior delineation of small vascular structures and tissue contrast within Clarify VE technology's region of interest (ROI) compared to the area outside the ROI.

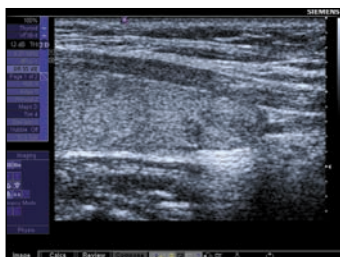


Figure 3A. Conventional imaging

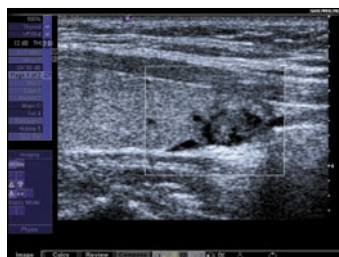


Figure 3B. Clarify VE technology improves contrast resolution in a thyroid

Clarify VE technology exhibits varying degrees of contrast resolution enhancement dependent on the level of tissue perfusion. For example, a highly perfused organ such as the kidney (see Figure 4A, 4B) will demonstrate a greater level of contrast enhancement than an organ of less perfusion, such as the liver (see Figure 5A, 5B). This is accomplished by modifying the pixels of the kidney to be darker (or more highly vascular) than those of the liver.

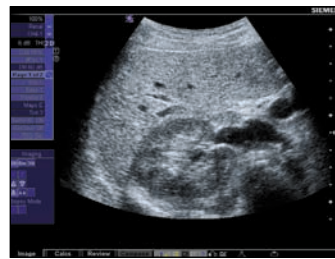


Figure 4A. Conventional imaging

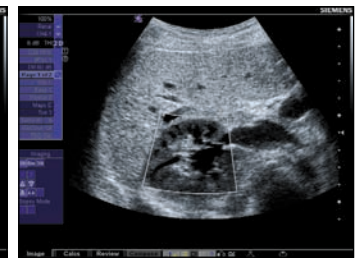


Figure 4B. Clarify VE technology enhances contrast resolution of renal parenchyma



Figure 5A. Conventional imaging



Figure 5B. Clarify VE technology reduces partial volume effect in hepatic veins with minimal impact to liver parenchyma

Conclusion

Through a unique and highly innovative application of real-time, adaptive, pixel-by-pixel analysis of B-mode and power Doppler information, Clarify VE technology:

- Reduces artifacts frequently seen in vessels and fetal heart chambers
- Improves boundary detection in vessels
- Improves contrast resolution within an organ and between organs
- Dramatically improves visualization of micro- and macrovasculature

With a single keystroke, vascular structures are instantly optimized, eliminating the need to adjust multiple parameters. By doing so, it offers the clinician an important new platform for heightened diagnostic confidence and patient care.

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Siemens AG Medical Solutions
Henkestrasse 127
D-91052 Erlangen
Germany
Tel: + 49 9131 84-0

www.siemens.com/ultrasound

Siemens Medical Solutions USA, Inc.
Ultrasound Division Headquarters
P.O. Box 7393
Mountain View, CA 94039-7393 USA
Tel: 1 800-228-4128
From outside the USA: +1 650-969-9112

Siemens Medical Solutions USA, Inc.
Ultrasound Division
P.O. Box 7002
Issaquah, WA 98027-7002 USA
Tel: 1 800-367-3569
From outside the USA: + 1 425-557-8704

Europe: +44 20 8479 7950
Asia Pacific: +65 6341 0990
Latin America: +1 786 845-0697

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