White Paper

CEUS

Contrast-Enhanced Ultrasound

esaote
Creativity in Healthcare

CEUS allows easy and accurate characterization of focal liver lesions. This not only identify the specific types of benign lesions, often with better accuracy than with CT,

The role of Contrast-Enhanced Ultrasound

The usage of second-generation microbubble ultrasound (US) contrast agents has considerably improved the diagnostic yield of US imaging in recent years because of its ability to very sensitively depict tumor vascularity.

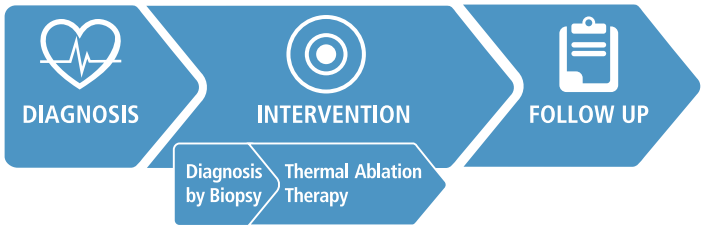
Contrast-enhanced US (CEUS) has the advantages of the absence of ionizing radiation, widespread availability, even at the bedside, and the possibility to characterize a lesion as soon as it is detected on conventional B-mode US, commonly used as the first technique for exploration of the liver and other areas.

Understanding of the enhancement features provided by CEUS according to tumor type enables imaging specialists to make more accurate characterization as well as give better advice to oncologists or other clinicians.

Esaote Contrast-Enhanced Ultrasound Technology

CnTI™ (Contrast Tuned Imaging) is MyLab™Eight eXP's (Esaote S.p.A., Genova, Italy) advanced technology for Contrast-Enhanced Ultrasound (CEUS) Imaging. Based on low mechanical index and real-time scanning, CnTI™ represents the best way to use second-generation contrast media (CM).

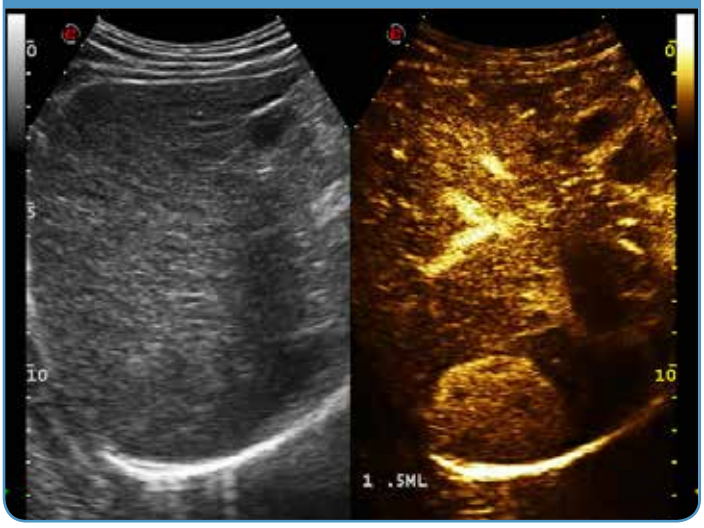
CnTI™ can be used for diagnosis and follow-up, as well as during interventional procedures. Thanks to its architecture based on linear pulser technology, the Esaote MyLab™Eight eXP Ultrasound system is capable of managing various typologies of pulsing techniques in order to optimize the beamforming management for a wide range of transducer types and clinical applications.



CnTI™ is available for a wide range of clinical applications (from Abdominal to Cardiology, also including Gynecology, Urology, MSK, Rheumatology, Surgery, Vascular, Thyroid, Small Parts, Breast and Interventional), as well as on a wide range of probes (2D and 3D Convex Transducers, 2D and 3D Linear Transducers, Phased Array, 2D and 3D Endocavity and Intraoperative).

Dual Contrast Enhanced Ultrasound on Liver (Early Phase)

Dual Contrast Enhanced Ultrasound on Liver



implies a very high capacity to distinguish benign from malignant lesions, but also to taking advantage of the high temporal and spatial resolutions of ultrasonography.

Prof. Fabio Piscaglia, S. Orsola-Malpighi Hospital, University of Bologna, Italy

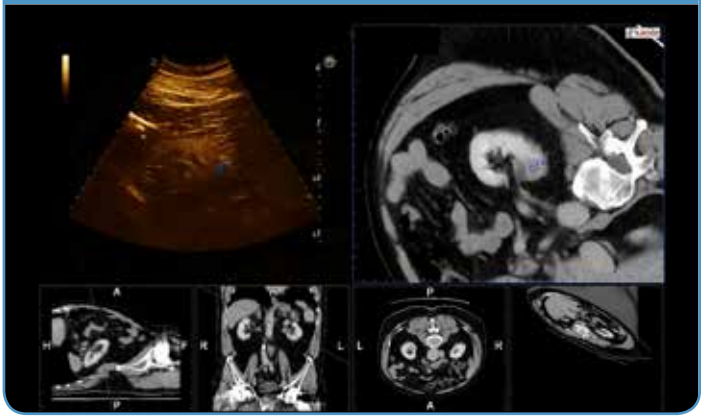
Dual Contrast Enhanced Ultrasound on Liver (Late Phase)

Intended use and state of art

Esaote CnTI™ has so far been used for applications including, but not limited to, the following:

- Liver lesion detection and characterization[2].
- Breast lesion detection and characterization[3].
- Prostate cancer detection and characterization[4].
- Assessment and management of joint disorders (arthritis)[5] and nerve lesion detection and characterization[6].
- Kidney functionality[7].
- Gynecology: diagnosis and management of adnexal masses with solid components[8].
- Left ventricular opacification (LVO)[9].
- Guidance and treatment assessment of ablation procedures[10,11].
- Neurosurgery for lesion characterization[12]

Contrast Enhanced Ultrasound on kidney with Virtual Navigator



Contrast Enhanced Ultrasound with high frequency on Thyroid

CnTI™ offers multiple tools for improved diagnostic confidence and ease of use:

- DCTI automatically captures the breaking frame and decorrelates the signal, eliminating all artifacts, by increasing the sensitivity in the late phase.
- CnTEI Technology is designed to maximize the visualization of the microcirculation in the arterial phase with a detail level and spatial resolution never achieved before.
- Dual Imaging for easier comparison and better/easier/more precise scanning plane optimization, available in any CnTI™ environment.
- Contrast Capture provides additional information by holding the signal detected from the contrast agent. Contrast Capture is particularly useful for a better spatial definition of non-perfused, necrotic, inactive areas.

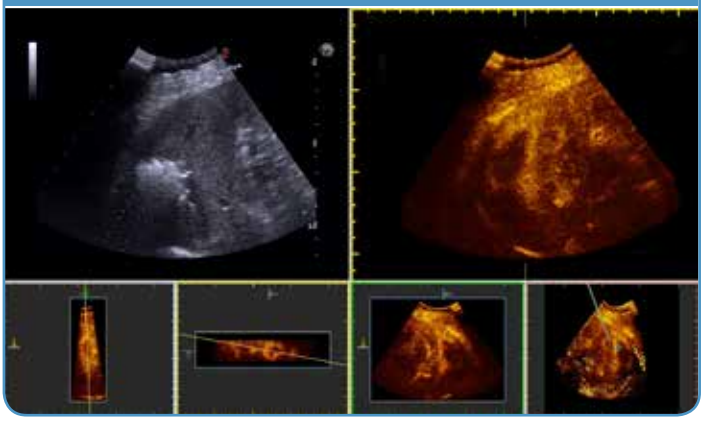
Future perspectives of CEUS in Liver Lesions (Prof. Fabio Piscaglia, S. Orsola-Malpighi Hospital, University of Bologna, Italy)

CEUS allows easy and accurate characterization of focal liver lesions. This not only implies a very high capacity to distinguish benign from malignant lesions, but also to identify the specific types of benign lesions (hemangioma, focal fatty infiltration/sparing, focal nodular hyperplasia, adenoma), often with better accuracy than with CT, taking advantage of the high temporal and spatial resolutions of ultrasonography. Furthermore, focal liver lesions discovered in patients with cirrhosis or advanced fibrosis can be assigned to one of the specific classes of the CEUS LI RADS system of the American College of Radiology (*https://www.acr.org/Quality-Safety/Resources/LIRADS*) (classes LR1 to LR5 and LR-M), also including the possibility to achieve a definitive and accurate diagnosis of hepatocellular carcinoma (LR5) or of benign lesions (e.g. hemangioma, LR1), with reduced need for biopsy and improved communications between ultrasound operators and hepatologists.

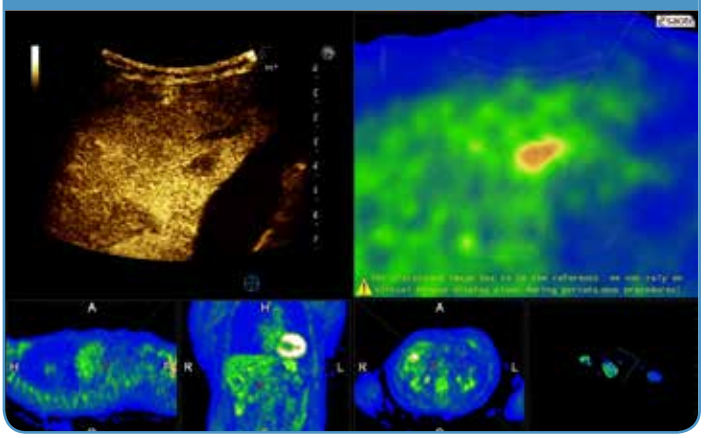
A further step in diagnosis and treatment with CEUS Fusion Imaging

CnTI™ can be used with Virtual Navigator Real-Time Multimodality Fusion Imaging Technology. Esaote Virtual Navigator offers the possibility to perform real-time fusion with multiple second modality imaging, making it possible to supplement the high anatomical definition volumes of MRI/CT with the Doppler/real-time capabilities of Ultrasound. The same can be done to combine the functional/molecular capabilities of PET/CT with the real-time and hemodynamics evaluation offered by Ultrasound. CnTI™ data can be fused together with MRI, CT, PET, 3D Ultrasound and/or 3D CEUS volumes.

Real-time Thermal Ablation with CEUS Volume Fusion Imaging



Contrast Enhanced Ultrasound with PETCT Fusion Imaging



Bibliographic References

[1] Piscaglia F, Lencioni R, Sagrini E, Pina CD, Cioni D, Vidili G, Bolondi L, **Characterization of focal liver lesions with contrast-enhanced ultrasound**, Ultrasound Med Biol. 2010 Apr;36(4):531-50. doi: 10.1016/j.ultrasmedbio.2010.01.004.

[2] Piscaglia F, Venturi A, Mancini M, Giangregorio F, Vidili G, Magnolfi F, Mirarchi M, Fornari F, Bolondi L, **Diagnostic features of real-time contrast-enhanced ultrasound in focal nodular hyperplasia of the liver**, Ultraschall Med. 2010 Jun, 31(3):276-82. doi: 10.1055/s-0028-1109852.

[3] Caumo F, Carbognin G, Casarin A, Pinali L, Vasori S, D'Onofrio M, Pozzi Mucelli R, **Angiosonography in suspicious breast lesions with non-diagnostic FNAC: comparison with power Doppler US**, Radiol Med. 2006 Feb;111(1):61-72.

[4] Xie SW, Li HL, Du J, Xia JG, Guo YF, Xin M, Li FH, **Contrast-enhanced ultrasonography with contrast-tuned imaging technology for the detection of prostate cancer: comparison with conventional ultrasonography**, BJU Int. 2012 Jun, 109(11):1620-6. doi: 10.1111/j.1464-410X.2011.10577.x.

[5] Mouterde G, Aegerter P, Correas JM, Breban M, D'Agostino MA., **Value of contrast-enhanced ultrasonography for the detection and quantification of enthesitis vascularization in patients with spondyloarthritis**, Arthritis Care Res (Hoboken), 2014 Jan, 66(1):131-8. doi: 10.1002/acr.22195.

[6] De Marchi A, Pozza S, Sutera R, Brach del Prever EM, Petraz M, Sena C, Linari A, Faletti C, **Study of neurinomas with ultrasound contrast media: review of a case series to identify characteristic imaging patterns**, Radiol Med. 2011 Jun, 116(4):634-43. doi: 10.1007/s11547-011-0653-1.

[7] Zhang L, Liang W, Xue GH, Ye M, Fang H, Zhang JW, **The clinical research of contrast-enhanced sonography in evaluating renal cortical perfusion during follow up of PTRAS**, Zhonghua Zhong liu za zhi [Chinese Journal of Oncology], 2010 Mar 23, 90(11):752-5.

[8] Testa AC, Timmerman D, Van Belle V, Fruscella E, Van Holsbeke C, Savelli L, Ferrazzi E, Leone FP, Marret H, Tranquart F, Exacoustos C, Nazzaro G, Bokor D, Magri F, Van Huffel S, Ferrandina G, Valentin L, **Intravenous contrast ultrasound examination using contrast-tuned imaging (CnTI) and the contrast medium SonoVue for discrimination between benign and malignant adnexal masses with solid components**, Ultrasound Obstet Gynecol. 2009 Dec, 34(6):699-710. doi: 10.1002/uog.7464.

[9] Porter TR et al., **Guidelines for the Cardiac Sonographer in the Performance of Contrast Echocardiography: A focus Update from the American Society of Echocardiography**, J Am Soc Echocardiogr 2014; 27:797-810.

[10] Yan K, Chen MH, Dai Y, Shen L, Jiang XL, **Results of enhanced ultrasonography in assessing hepatoma treated with radiofrequency ablation**, Zhonghua Zhong liu za zhi [Chinese Journal of Oncology], 2005, 27(1):41-44.

[11] Hu B, Hu B, Chen L, Li J, Huang J, **Contrast-enhanced ultrasonography evaluation of radiofrequency ablation of the prostate: a canine model**, J Endourol. 2010 Jan, 24(1):89-93. doi: 10.1089/end.2009.0191.

[12] Prada et al., **Intraoperative Cerebral Glioma Characterization with Contrast Enhanced Ultrasound**, BioMed Research International, Volume 2014 (2014), Article ID 484261, 9 pages, http://dx.doi.org/10.1155/2014/484261

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Technology and features are system/configuration dependent. The use of Contrast Agents in the USA is limited by FDA to the left ventricle opacification and to characterization of focal liver lesions. Specifications subject to change without notice. Information might refer to products or modalities not yet approved in all countries. Product images are for illustrative purposes only. For further details, please contact your Esaote sales representative.