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Editorial

Developments in the application of high resolution ultrasound in clinical diagnostics

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This issue of *Clinical Hemorheology and Microcirculation* is dedicated to the developments in the application of high resolution ultrasound in clinical diagnostics.

The editors sought to provide information on the latest procedures for ultrasound bringing together outstanding original articles and reviews about new diagnostic information obtained by recent technological advances but also clarify well-established or controversial subjects. A very important step forward in ultrasound technology towards clinical application was the introduction of microbubbles as contrast enhancer. Contrast enhanced ultrasound (CEUS), performed with the intravenous injection of microbubble contrast agents applying the low mechanical index (MI) technique of contrast harmonic imaging has expanded the horizon for ultrasound imaging. CEUS provides a technique with superb sensitivity from early arterial phase up to late venous enhancement in dynamic realtime vascular imaging. For the first time, this ultrasound technology allows the non-invasive demonstration of blood flow of inner organs at a microcirculatory level [1, 2]. Further, the purely intravascular microbubbles enable ultrasound to be used to monitor changes in the blood flow of tumors and in inflamed areas in a diagnostic approach but also for therapy control. Its performance without any requirement for ionizing radiation and with no nephrotoxicity makes it a compelling choice in many clinical arenas and is now FDA approved for liver imaging, and also for children [1–8].

In this special issue, a first study evaluated factors which are associated with the initial incomplete ablation in radiofrequency ablation (RFA) for thyroid nodules [2]. Recent intraoperative studies reported the results of CEUS for immediate assessment of ablation status after RFA of hepatic malignancies [3]. These two articles showed the benefit of CEUS in the treatment control for ablation of solid nodules in various organs in terms of the virtues of CEUS such as real-time scanning, easy performance, and immediate assessment. In addition to qualitative evaluation for characterization [4, 5], quantitative evaluation of blood flow perfusion is also available with use of CEUS [6]. Other important applications are the assessment of vascular diseases such as vascular complications after liver transplantation or the detection of endoleaks after endovascular aortic repair (EVAR) [7, 8] or post-operative complications [9].

In addition and complement to CEUS, ultrasound elastography has gained increasing attention in recent years. There are two types of ultrasound elastography techniques: strain elastography and shear wave elastography (SWE). Both can be used to assess the tissue's stiffness, whereas the former is qualitative and the latter is quantitative [11–14]. The tissue stiffness can be denoted by Young's modulus (in kPa) or shear wave velocity (SWV) (in m/s). SWE such as transient elastography and the acoustic radiation force impulse technique of shear wave imaging are now also playing a pivotal role in the study of tissue fibrosis. Some studies have shown that elastography can detect both the progression and regression of fibrosis. Various SWE have been introduced in clinical practice and in this issue He et al. firstly evaluated the difference between two SWE in characterization of thyroid nodules [15]. Moreover, SWE might also be useful in assessing the patient's prognosis in patients with malignancy [16].

For both applications guidelines already exist [1, 9–11] and it can be anticipated that additional guidelines will be forthcoming as CEUS and elastography technology evolve and more clinical studies and new applications are developed.

References

[1] M. Claudon, C.F. Dietrich, B.I. Choi, D.O. Cosgrove, M. Kudo, C.P. Nolsøe, F. Piscaglia, S.R. Wilson, R.G. Barr, M.C. Chammas, N.G. Chaubal, M.-H. Chen, D.A. Clevert, J.M. Correas, H. Ding, F. Forsberg, J.B. Fowlkes, R.N. Gibson, B.B. Goldberg, N. Lassau, E.L.S. Leen, R.F. Mattrey, F. Moriyasu, L. Solbiati, H-P. Weskott and H.-X. Xu, Guidelines, Good, Clinical, Practice Recommendations for Contrast Enhanced Ultrasound (CEUS) in the Liver – Update 2012. A WFUMB-EFSUMB Initiative in Cooperation With Representatives of AFSUMB, AIUM, ASUM, FLAUS and ICUS, *Ultraschall in Med* **34** (2013), 11–29.

[2] C.K. Zhao, H.X. Xu, F. Lu, L.P. Sun, Y.P. He, L.H. Guo, X.L. Li, X.W. Bo and W.W. Yue, Factors associated with initial incomplete ablation for benign thyroid nodules after radiofrequency ablation: First results of CEUS evaluation, *Clin Hemorheol Microcirc* **65** (2017), 393–405. doi: 10.3233/CH-16208

[3] N. Platz Batista da Silva, L.P. Beyer, M.C. Hottenrott, C. Hackl, H.J. Schlitt, C. Stroszczynski, P. Wiggermann and E.M. Jung, Efficiency of contrast enhanced ultrasound for immediate assessment of ablation status after intraoperative radiofrequency ablation of hepatic malignancies, *Clin Hemorheol Microcirc* **66** (2017), 357–368. doi: 10.3233/CH- 179112

[4] J. Rübenthaler, K.J. Paprottka, E. Hameister, K. Hoffmann, N. Joiko, M. Reiser, D. Rjosk-Dendorfer and D.A. Clevert, Contrast-enhanced ultrasound (CEUS) prediction of focal liver lesions in patients after liver transplantation in comparison to histopathology results, *Clin Hemorheol Microcirc* **66** (2017), 303–310. doi: 10.3233/CH-179104

[5] H.-X. Xu, C.-K. Zhao, L.-H. Guo and L.-P. Sun, A primary hepatic angiosarcoma mimicking intrahepatic cholangio- carcinoma on conventional ultrasound and contrast-enhanced ultrasound: A case report and review of literatures, *Clin Hemorheol Microcirc* **66** (2017), 7–14. doi: 10.3233/CH-16212

[6] B. Schellhaas, M.J. Waldner, R.S. Görtz, F. Vitali, C. Kielisch, L. Pfeifer, D. Strobel, R. Janka, M.F. Neurath and D. Wildner, Diagnostic accuracy and interobserver variability of Dynamic Vascular Pattern (DVP) in primary liver malignancies – a simple semiquantitative tool for the analysis of contrast enhancement patterns, *Clin Hemorheol Microcirc* **66** (2017), 317–331. doi: 10.3233/CH-16238

[7] J. Rübenthaler, K.J. Paprottka, E. Hameister, K. Hoffmann, N. Joiko, M. Reiser, D. Rjosk-Dendorfer and D.A. Clevert, Diagnostic accuracy of contrast-enhanced ultrasound (CEUS) in monitoring vascular complications in patients after liver transplantation – diagnostic performance compared with histopathological results, *Clin Hemorheol Microcirc* **66** (2017),

311–316. doi: 10.3233/CH-179105
[8] J. Rübenthaler, M. Reiser, V. Cantisani, D. Rjosk-Dendorfer and D.A. Clevert, The value of contrast-enhanced ultrasound (CEUS) using a high-end ultrasound system in the characterization of endoleaks after endovascular aortic repair (EVAR),
Clin Hemorheol Microcirc **66** (2017), 283–292. doi: 10.3233/CH-179102
[9] M. Georgieva, L. Beyer, I. Goecze, C. Stroszczynski, P. Wiggermann and E.M. Jung, Contrast-enhanced ultrasound (CEUS) in an interdisciplinary intensive care unit (ICU): Diagnostic efficacy in the assessment of post-operative com- plications compared to contrast-enhanced computed tomography (CECT): First Results, *Clin Hemorheol Microcirc* **66** (2017), 277–282. doi: 10.3233/CH-179101

[10] F.J. Putz, A. Erlmeier, I. Wiesinger, N. Verloh, C. Stroszczynski, B. Banas and E.M. Jung, Contrast-enhanced ultrasound (CEUS) in renal imaging at an interdisciplinary ultrasound centre: Possibilities of dynamic microvascularisation and perfusion, *Clin Hemorheol Microcirc* **66** (2017), 293–302. doi: 10.3233/CH-179103

[11] J. Bamber, D. Cosgrove, C.F. Dietrich, J. Fromageau, J. JBojunga, F. Calliada, V. Cantisani, J-M Correas, M. D´Onofrio, E.E. Drakonaki, M. Fink, M. Friedrich-Rust, O.H. Gilja, R.F. Havre, C. Jenssen, A.S. Klauser, R. Ohlinger, A. Saftoiu, F. Schaefer, I. Sporea and F. Piscaglia, The EFSUMB Guidelines and Recommendations on the Clinical Use of Ultrasound Elastography 2012. Part 1: Basic Principles and Technology, *Ultraschall in Med* **34** (2013), 169–184.

[12] D. Cosgrove, F. Piscaglia, J. Bamber, J. Bojunga, J.-M. Correas, O.H. Gilja, A.S. Klauser, I. Sporea, F. Calliada, V. Cantisani, M. D´Onofrio, E.E. Drakonaki, M. Fink, M. Friedrich-Rust, J. Fromageau, R.F. Havre, C. Jenssen, R. Ohlinger, A. Săftoiu, F. Schaefer and C.F. Dietrich, The EFSUMB Guidelines and Recommendations on the Clinical Use of Ultrasound Elastography 2012. Part 2: Clinical Applications, *Ultraschall in Med* **34** (2013), 238–253.

[13] R.G. Barr, D. Cosgrove, M. Brock, V. Cantisani, J.M. Correas, A.W. Postema, G. Salomon, M. Tsutsumi, H.X. Xu and C.F. Dietrich, WFUMB Guidelines and Recommendations on the Clinical Use of Ultrasound Elastography: Part 5. Prostate, *Ultrasound Med Biol* **43**(1) (2017), 27–48.

[14] V.I. Teusch, A.P. Piehler, W. Uller, R. Müller-Wille, L. Prantl, C. Stroszczynski, W.A. Wohlgemuth and E.M. Jung, Value of different ultrasound elastography techniques in patients with venous malformations prior to and after sclerotherapy, *Clin Hemorheol Microcirc* **66** (2017), 347–355. doi: 10.3233/CH-179106

[15] Y.P. He, H.X. Xu, D. Wang, X.L. Li, W.W. Ren, C.K. Zhao, X.W. Bo, B.J. Liu and W.W. Yue, First experience of comparisons between two different shear wave speed imaging systems in differentiating malignant from benign thyroid nodules, *Clin Hemorheol Microcirc* **65** (2017), 349–361. doi: 10.3233/CH-16197

[16] H. Pu, L.-X. Zhao, M.-H. Yao, G. Xu, H. Liu, H. Xu and R. Wu, Conventional US combined with acoustic radiation force impulse imaging (ARFI) for prediction of triple-negative breast cancer and the risk of lymphatic metastasis, *Clin Hemorheol Microcirc* **65** (2017), 335–347. doi: 10.3233/CH-16196