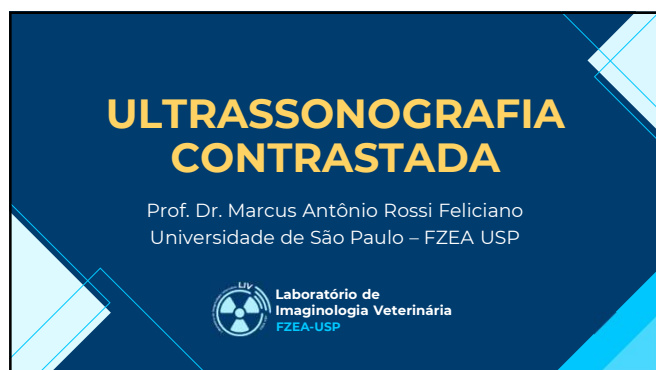




1



2

MEU HISTÓRICO

- 🕒 2013 - 2017 - Jovem Pesquisador FAPESP - FCAV
- Elastografia, ultrassonografia com contraste por microbolhas e Doppler como métodos de diagnóstico das neoplasias mamárias, afecções prostáticas e testiculares em cães
- Bolsa Jovem Pesquisador, auxílio pesquisa JP e bolsa de iniciação científica

⚠️ Criação do nosso 1º laboratório de Ultrassonografia

LIV FZEA-USP

3



4



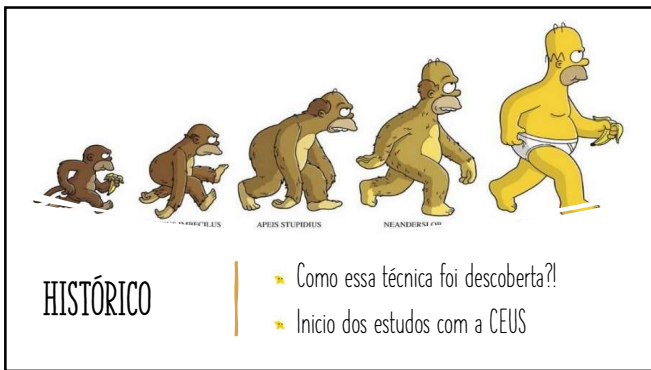
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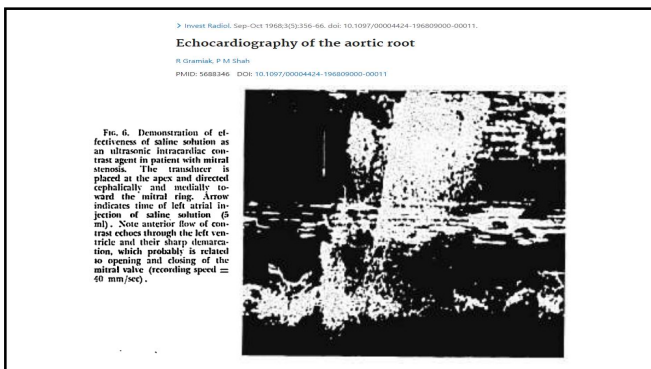
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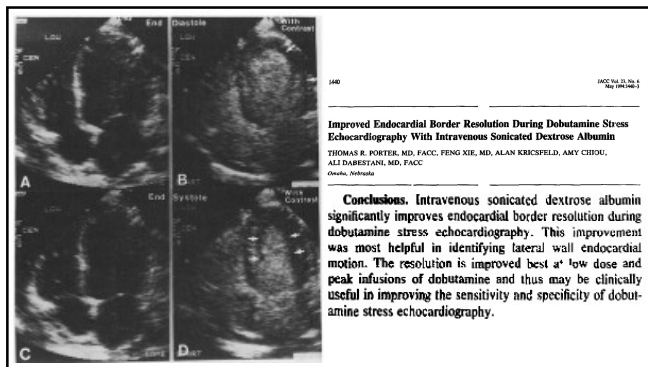
8



9

Conclusions. Myocardial contrast echocardiography performed with left main coronary artery injections of sonicated albumin can potentially be used with an on-line ultrasound system to instantaneously determine coronary flow reserve in humans with angiographically normal coronary arteries. This system should also be applied to assess coronary flow reserve in the setting of unbalanced coronary artery disease in humans and thus provide a quick, safe means of determining functional stenosis severity at the time of diagnostic cardiac catheterization. However, the role of intramyocardial blood volume changes on the flow reserve ratios obtained from the time-intensity curve must be investigated. In addition, further development in the existing on-line video intensity analysis system to include digital storage, as well as computer algorithms to correct for cardiac translation, is needed to enhance the application of this technique in detecting coronary flow reserve in the cardiac catheterization laboratory.

13



14

Circulation Research

JOURNAL OF THE AMERICAN HEART ASSOCIATION

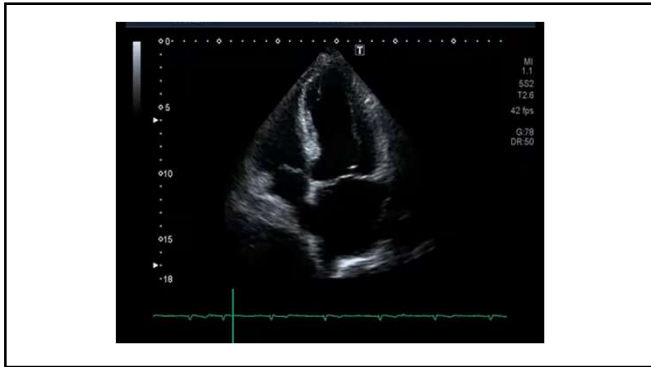


In vivo myocardial kinetics of air-filled albumin microbubbles during myocardial contrast echocardiography. Comparison with radiolabeled red blood cells.
A R Jayaweera, N Edwards, W P Glasheen, F S Villanueva, R D Abbott and S Kaul

Circ Res. 1994;74:1157-1165
doi: 10.1161/01.RES.74.6.1157

Circulation Research is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1994 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7330. Online ISSN: 1524-4571

15



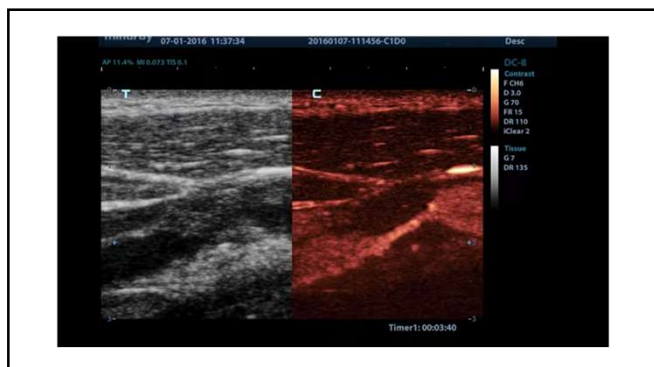
19



20



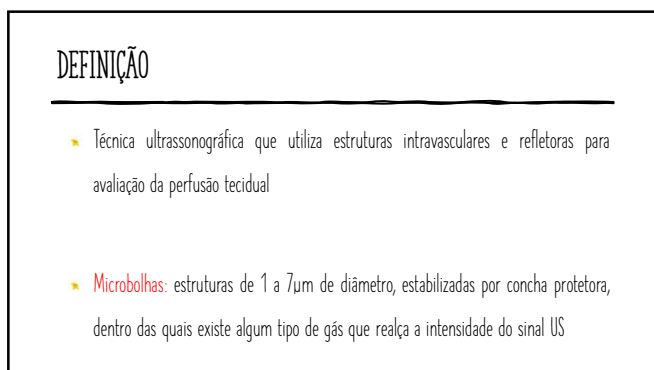
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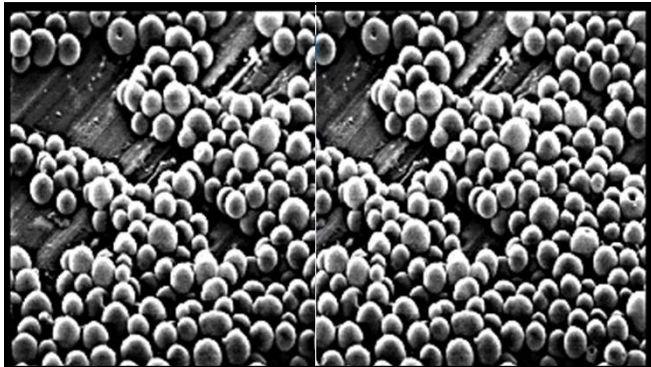
22



23



24



25

Table 1 Microbubble contrast agents classified according to the filling gas

Air (Nitrogen)	Perfluorocarbon	Sulfur hexafluoride
-Abunex (Mallinckrodt) ^a	-BRI 4 (Bracco)	-SonoVue (Bracco) ^b
-Echovist (Shering) ^b	-Definity (Bristol-Myers Squibb Medical Imaging)	
-Levovist (Shering) ^b	-Echogen (Sonos Pharmaceuticals) ^a	
-Myonap (Quadrant) ^a	-Imagent-Imavist (Alliance)	
-Quantison (Quadrant) ^a	-Optison (GE Healthcare) ^a	
-Sonavist (Shering) ^b	-Sonazoid (GE Healthcare)	

Veterinary Radiology & Ultrasound 

ORIGINAL INVESTIGATION

Novel contrast agent Visphere™ is feasible for contrast-enhanced ultrasonography in dogs

Lee-Shuan Lin  Cheng-Shu Chung

First published: 22 May 2020 | <https://doi.org/10.1111/Arv.12869>



26

TIPOS DE CONTRASTES

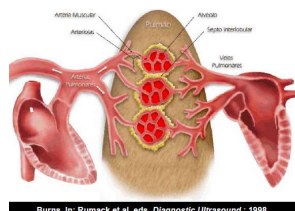
Primeira Geração	Segunda geração	Terceira geração
- Contrastes que utilizavam gases altamente solúveis; - Compostos por microbolhas de ar e a concha protetora varia de acordo com a apresentação comercial; - Limitada aplicabilidade clínica devido a longevidade reduzida.	- Gás de baixa solubilidade e maior estabilidade; - Duração prolongada na circulação (até 10 minutos); - Microbolhas de 1 a 10 µm; - Próximas ao tamanho da hemácia e suficientemente grandes para não se difundir para o espaço extracelular; - Pequenas o suficientes para passar pelo sistema pulmonar.	- Produtos recentemente desenvolvidos; - Ainda disponíveis de forma limitada no mercado; - São microbolhas de menores dimensões (3 µm) e que permanecem por mais tempo nos capilares.

27

CARACTERÍSTICAS IMPORTANTES

☛ suficientemente grandes para não se difundir para o espaço intracelular ou intersticial!

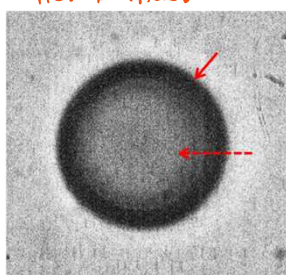
☛ ... mas suficientemente pequenas para passar pelo sistema capilar pulmonar!



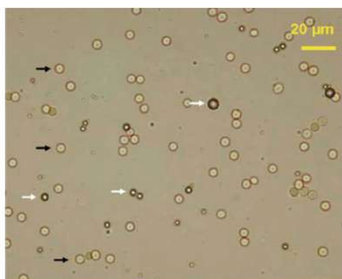
Burns. In: Rumack et al. eds. *Diagnostic Ultrasound*. 1998

28

Microbolhas!



D. Cosgrove / European Journal of Radiology 60 (2006) 324-330



E. Quarta / Eur Radiol (2007) 17: 1995-2008

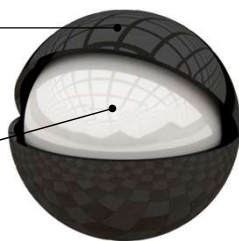
29

1. Tamanho ótimo
2. Preenchidas por um gás pesado, inerte e pouco solúvel
3. Camada externa estável, metabolizável, excreção e de baixa toxicidade

← Cápsula
albumina, fosfolípidios, açúcares ou
biopolímeros

← Gás

1ª geração = Ar
2ª geração = fluoro-carbonado
3ª geração = hexafluoreto sulfúrico



Tamanho
<10 µm
5 - 7 µm = Eritrócitos =
Estabilidade

30

IMPORTANTE!

✎ Eliminação: gás pelos pulmões e componentes da concha são metabolizados ou filtrados pelos rins e eliminados - **10 a 15 min após a injeção**

Efeitos secundários - < 2% - cefaleia, dor na região rena, hipersensibilidade, náuseas, hemólise, agregação plaquetária e lesão endotelial

Gestantes e em pacientes pediátricos/ doentes cardíacos crônicos - *uso contraindicado!*

31

IMPORTANTE!

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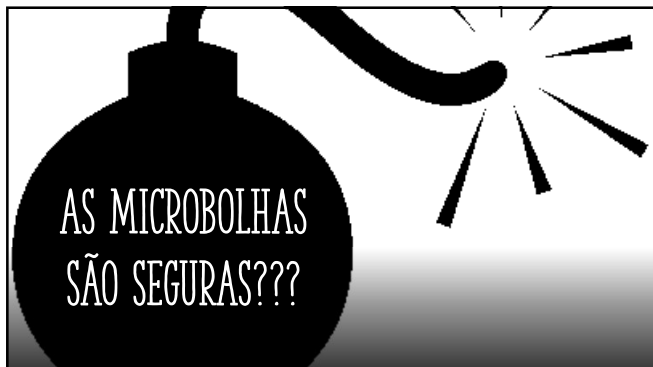
Gestantes e em pacientes pediátricos/ doentes cardíacos crônicos??? - *uso contraindicado!*

32

DIFERENÇA DOPPLER VERSUS CEUS



33



34

Welcome Guest user Sign in

Abstract
Journal of the American Veterinary Medical Association
May 1, 2013, Vol. 242, No. 9, Pages 1255-1259
doi: 10.2460/javma.242.9.1255

Safety of contrast-enhanced ultrasonography in dogs and cats: 488 cases (2002–2011)

Objective—To determine the incidence of adverse events within 24 hours after contrast-enhanced ultrasonography (CEUS) in dogs and cats and compare the risk of death within 24 hours after imaging for animals that underwent ultrasonography with and without injection of a contrast agent.

Results—Of the 411 case dogs, 3 had immediate adverse events (vomiting or syncope) and 1 had a delayed adverse event (vomiting). No adverse events were recorded for case cats. Twenty-three of 367 (6.4%) clinically ill case animals and 14 of 262 (5.3%) clinically ill control animals died within 24 hours after ultrasonography; risk of death did not differ between cases and controls.

Conclusions and Clinical Relevance—Results indicated that CEUS was safe in dogs and cats.

FELICIANO, M.A.R. 35

35

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FELICIANO, M.A.R. 36

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FELICIANO, M.A.R.38

38

» Articles » US Cardiology - Volume 6 Issue 1 » Safety And Risk-Benefit Profile Of Microbubble Contrast Agents In Echocardiography

Safety And Risk-Benefit Profile Of Microbubble Contrast Agents In Echocardiography

Tajyeb M Khumri, Michael L. Main

Several large-scale ultrasound contrast agent safety studies have been completed, including ~200,000 patients.

Of these, 8.4% had at least one treatment-related adverse reaction. There were eight deaths, which were attributed to underlying disorders. There were 11 other serious adverse events, including one hypersensitivity reaction with urticaria and pruritus; other patients experienced dizziness, chest pain, dyspnoea or back pain. Headache (2.3%) and back and renal pain (1.2%) were the most common side effects, resolved spontaneously without treatment.

Contraindicated in patients with right-to-left, bi-directional or transient right-to-left cardiac shunts that can allow microspheres to bypass the pulmonary particle-filtering mechanisms and directly enter the arterial circulation, potentially resulting in microvascular occlusion and ischaemia. These agents should also not be injected intra-arterially or in patients who have a known hypersensitivity to perflutren. The use of Optison is also contraindicated in patients with an allergy to egg (albumin). Pregnant? and Children?

39

COMO FUNCIONAM?!

- ✦ Aumentam a reflexão do sinal provindo do sangue!
- ✦ Ressona em frequências utilizadas para a ultrassonografia diagnóstica



40



PARA ISSO
ACONTECER...

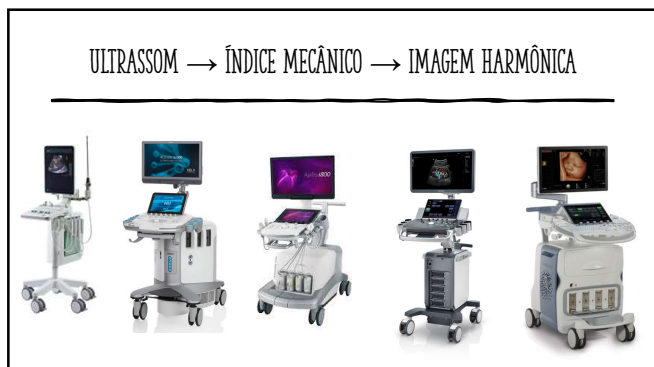
41

IMPORTANTE!

✦ Aparelhos:

- Ultrassom com tecnologia que permita otimizar a imagem contrastada → Índice mecânico
 - Imagem harmônica, harmônica Doppler, ultra-harmônica, harmônica Power Doppler
 - Sequência de pulso de contraste
 - eco de retorno o dobro do transmitido
 - filtrado, maximizando o sinal e exibindo imagem com o mínimo de artefatos
- Energia ultrassônica

42



43

- 1 Microbolhas sofrem redução do diâmetro - compressão gerada por único pulso ultrassônico
- 2 Quando o pulso se interrompe - expansão das microbolhas, ressonância e oscilação de forma não linear - "emissão de frequências harmônicas e sub-harmônicas"
- 3 Transdutor de 2ª harmônica capta apenas a 2ª frequência harmônica - sinal mais puro e livre de artefatos - visualização de vasos com 40 μ m.
- PROBLEMA - um único pulso de ultrassom destrói as bolhas - impede o preenchimento por completo da rede capilar
- Emissão de onda ultrassônica com índice mecânico extremamente baixo - preserva integridade das microbolhas

Harmônica

Contraste

Frequência (MHz)

44

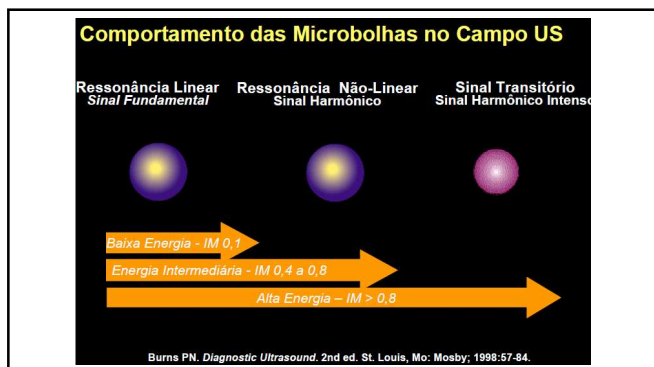
Harmônica e Filtro de Sinal

Sinal Refletido

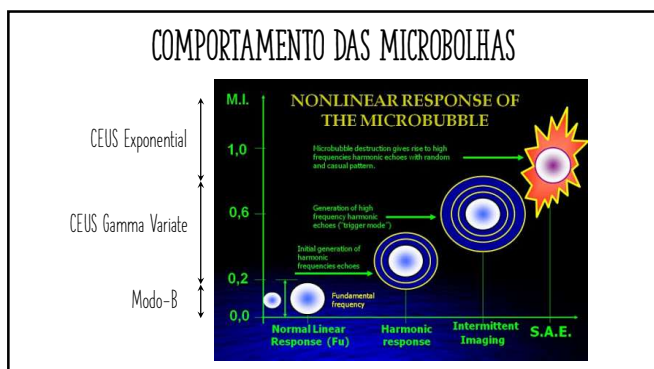
Filter

Sinal transformado em Imagem

45



46

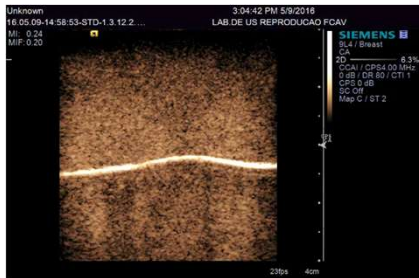


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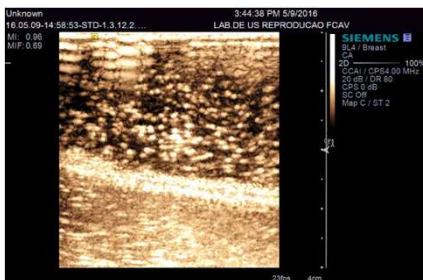
48

HARMÔNICO → ÍNDICE MECÂNICO MÉDIO



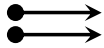
49

HARMÔNICO → SUBINDO UM POUCO O ÍNDICE MECÂNICO MÉDIO



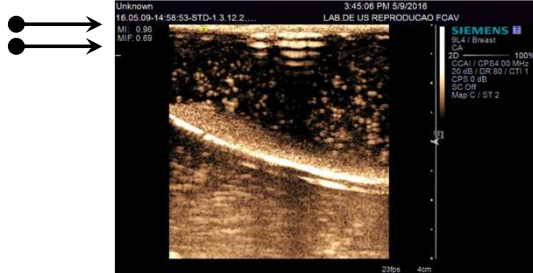
50

BURST + HARMÔNICO → > ÍNDICE MECÂNICO



51

BURST + HARMÔNICO → > ÍNDICE MECÂNICO



52

ENTENDERAM COMO AS
MICROBOLHAS FUNCIONAM?!

53

RESUMINDO... PARA QUE SERVEM?



Intensifica modo B: áreas hiperecoicas mais hiperecoicas e hipoecoicas relativamente mais hipoecoicas

Refletividade vascular: melhora sinal Doppler

Permite a avaliação da existência, da direção e do volume de fluxos

Avaliação da perfusão tecidual da *MACRO E DA MICROCIRCULAÇÃO*

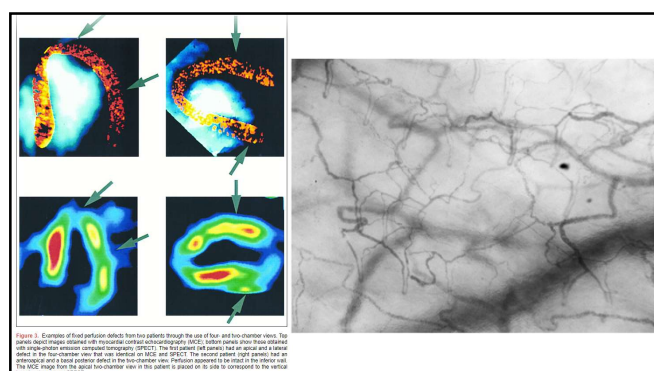
Avalia preenchimento tecidual

54

54

Fluxo sanguíneo	Doppler → Melhor → Mais complicado
	Biomarcadores → Piores → Mais simples
	Doppler Laser → Similar → Invasivo
	Fluxometro → Melhor → Invasivo
Perfusão	Biomarcadores → Similares/ piores → Custo, invasividade, complexidade
	TC Contrastada → Pior → alto risco do contraste, radiação, anestesia
	RM Contrastada → Similar → Custo, anestesia, complexidade
	Cintilografia Tc99 → Similar → alto risco do contraste, complexidade
	Citocam → Similar → Radiação, rico contraste, complexidade

55



56



57

O QUE AVALIAMOS NESTA TÉCNICA?

Preenchimento tecidual
(padrão): Homogêneo ou heterogêneo

Intensidade do preenchimento
em relação à: Hiperintenso, hipo ou iso

Áreas de isquemia
Presença ou ausência
Delimitação

Direção do contraste (fluxo):
Centrípeto, centrífugo ou difuso

QUALITATIVO

58

58

Padrão heterogêneo
Hiperintenso
Fluxo difuso

9:17:26 AM 2/4/2014
LAB DE US REPRODUCA...
SIEMENS
S4 / Breast
D
0.80%
COPI / GP54.00 MHz
3 dB / DR 80
CR 1.00
SC Off
Map C / ST 2
00:00:02 17fps 5.5cm
FELICIANO, MAR
59

59

Padrão homogêneo
Hiperintenso
Fluxo difuso

OPUS MINORAY
21-09-2022 15:43:13
Contrast
AP 0.0% M 0.000
C11-2a
Carotid-1 (5kg) Abdomen
Timer: 00:00:00
60

60

SISTEMA DE AVALIAÇÃO SUBJETIVO → QUALITATIVO

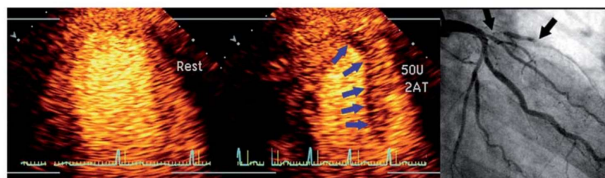


Fig. 4. Dobutamine stress real-time myocardial contrast perfusion echocardiography showing normal myocardial perfusion at rest (image on left) and subendocardial perfusion defect in the anterior septum at peak dobutamine stress (middle image). The coronary angiography demonstrated subocclusion of the left anterior descending coronary artery (Reproduced with permission, Elhendy A, et al. Noninvasive diagnosis of coronary artery disease in patients with diabetes by dobutamine stress real-time myocardial contrast perfusion imaging. Diabetes Care 2005 Jul; 28(7):1662-7).
Taddei & Mathias Junior, 2016

61

O QUE AVALIAMOS NESTA TÉCNICA?

QUANTITATIVO

Bolus → Gamma Variate

- Pico de Intensidade
- Tempo para o pico
- (a) velocidade de entrada
- (b) velocidade de saída
- Tempo médio de transmissão

Infusão contínua → Exponential

- Pico de Intensidade
- Tempo para o pico
- Velocidade de perfusão
(mililitros por min)

62

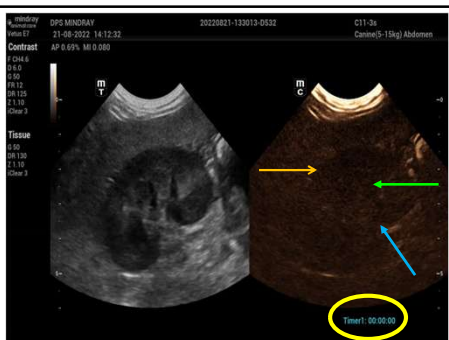
Bolus

Rim

Fase cortical

Fase medular

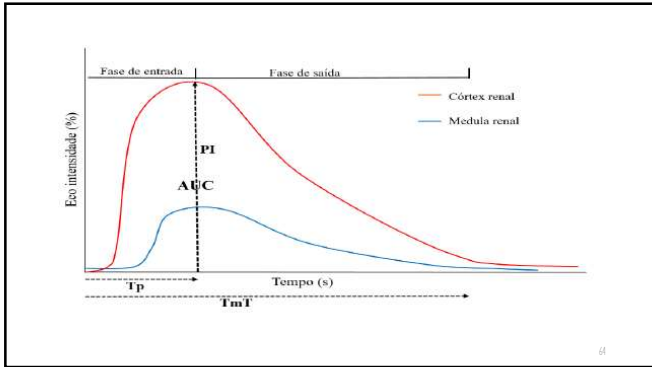
Fase vascular



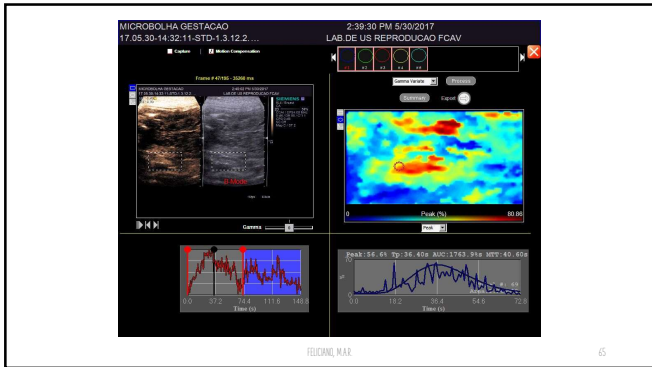
FELICIANO, M.A.R.

63

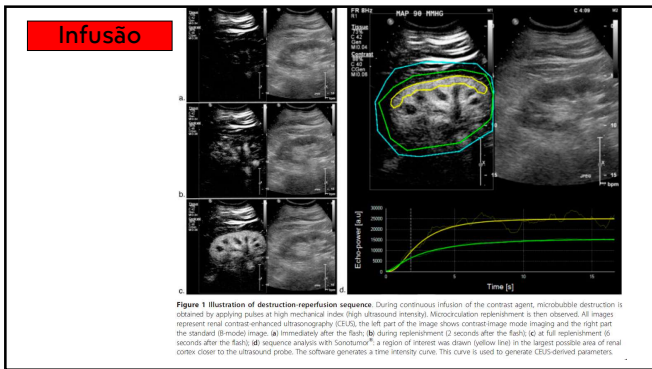
63



64



65



66



67

CONTRASTE

- SonoVue® (Bracco, São Paulo, SP, Brasil)
- R\$ 400,00 (frasco 5ml)
- Dose: 0,01 - 0,05 ml/kg de PV - IV (cefálica/jugular) + solução salina
- Duração máxima na circulação: 15 minutos
- Vídeos: 2- 3 minutos por órgão
- Onde comprar? Aparelhos?



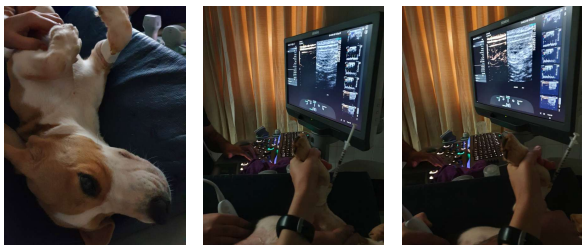
68

APLICAÇÃO CONTRASTE



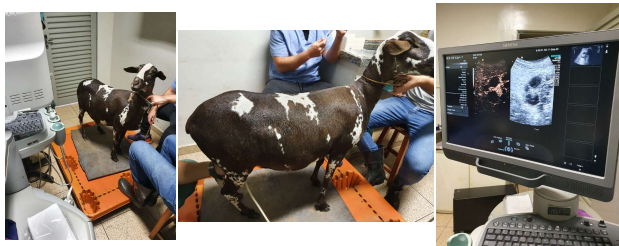

69

APLICAÇÃO CONTRASTE



70

APLICAÇÃO CONTRASTE



71

AS TRÊS PRINCIPAIS APLICAÇÕES!

1. AVALIAR A FUNÇÃO TECIDUAL
2. ESTUDAR POSSÍVEIS CARACTERÍSTICAS DE MALIGNIDADE
3. RUPTURAS



72

PREPARADOS?!



73

BAÇO



Citation: Canejo-Teixeira, R.; Lima, A.; Santana, A. Applications of Contrast-Enhanced Ultrasound in Splenic Studies of Dogs and Cats. *Animals* 2022, 12, 2104. <https://doi.org/10.3390/ani12162104>



animals

Review

Applications of Contrast-Enhanced Ultrasound in Splenic Studies of Dogs and Cats

Rute Canejo-Teixeira ^{1,2,*}, Ana Lima ^{1,*} and Ana Santana ^{1,2,3,4}

74

Common and Uncommon Features of Focal Splenic Lesions

The spleen is a parenchymal organ with a superficial location, making it well suited for CEUS examination. When observed by CEUS, the spleen perfusion dynamics differ from the liver, where there is dual blood supply, and they are similar to those seen on a contrast-enhanced CT scan, although with better vascular definition. Usually within the first 20 s after the contrast agent injection, microbubble contrast is seen within the splenic artery and its branches. Subsequently, the opacification becomes inhomogeneous, producing the so-called “zebra” pattern [60,61]. The splenic enhancement becomes homogeneous shortly thereafter, and the overall enhancement lasts only a few minutes [60,61].

Morphologic abnormalities, including focal masses and diffuse alterations (with or without overall splenic enlargement), are common in dogs and cats, as is nodular splenic disease [62–68]. This has made CEUS a powerful imaging tool to evaluate and detect splenic abnormalities [17]. Because CEUS has been incorporated into everyday clinical practice, malignant diseases such as focal lymphomatous infiltration, metastatic deposits, benign cysts, traumatic fractures, and hemangiomas can be detected and characterized without the need for further imaging [17,58–68]. Hence, in the new era of CEUS, more patients benefit from the radiation-free investigation of splenic pathologies with a high diagnostic accuracy.

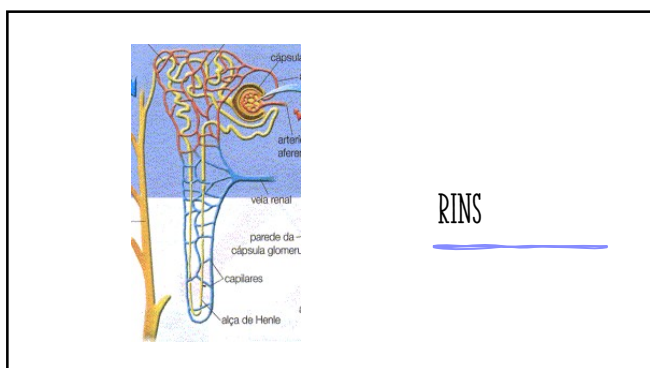
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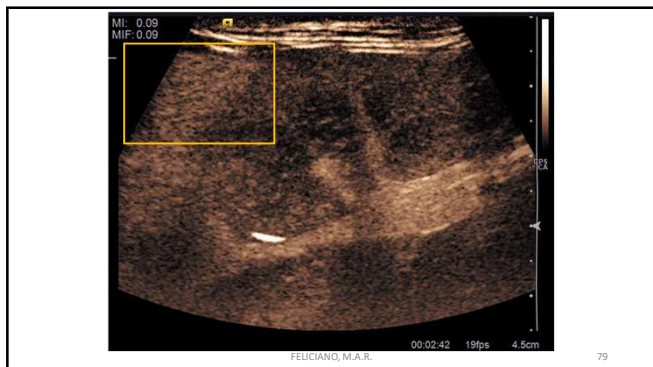
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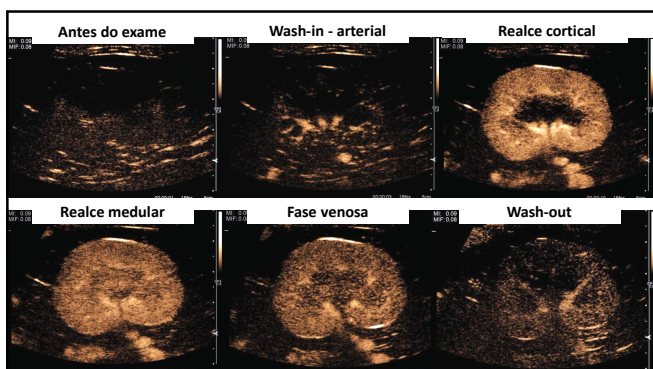
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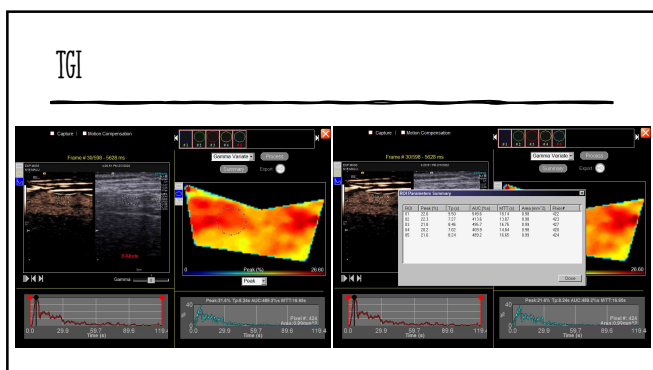
78



79



80



81

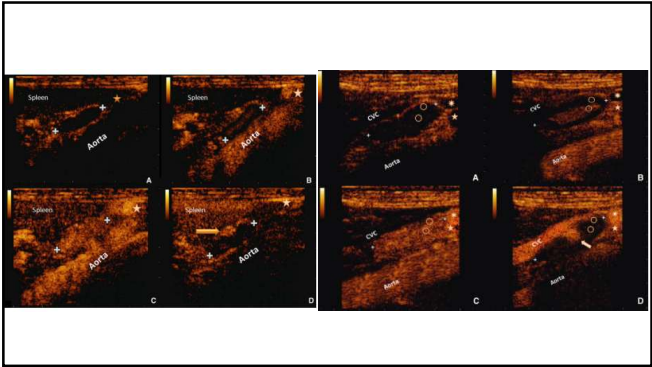
ADRENAIS

CONTRAST-ENHANCED ULTRASONOGRAPHY OF THE NORMAL CANINE ADRENAL GLAND

PASCALINE PEY, MASSIMO VIGNOLI, HENDRIK HAERS, LUC DUCHATEAU, FEDERICA ROSSI, JIMMY H. SAUNDERS

Contrast-enhanced ultrasonography is useful in differentiating adrenal gland adenomas from nonadenomatous lesions in human patients. The purposes of this study were to evaluate the feasibility and to describe contrast-enhanced ultrasonography of the normal canine adrenal gland. Six healthy female Beagles were injected with an intravenous bolus of a lipid-shelled contrast agent (SonoVue[®]). The aorta enhanced immediately followed by the renal artery and then the adrenal gland. Adrenal gland enhancement was uniform, centrifugal, and rapid from the medulla to the cortex. When maximum enhancement was reached, a gradual homogeneous decrease in echogenicity of the adrenal gland began and simultaneously enhancement of the phrenicoabdominal vessels was observed. While enhancement kept decreasing in the adrenal parenchyma, the renal vein, caudal vena cava, and phrenicoabdominal vein were characterized by persistent enhancement until the end of the study. A second contrast enhancement was observed, corresponding to the refilling time. Objective measurements were performed during the images for off-line image analysis using Image J (ImageJ[®]). The shape of the time-intensity curve reflecting adrenal perfusion was similar in all dogs. Ratios of the values of the cortex and the medulla to the values of the renal artery were characterized by significant differences from initial upstroke to the peak, allowing differentiation between the cortex and the medulla for both adrenal glands only in this time period. Contrast-enhanced ultrasonography of the adrenal glands is feasible in dogs and the optimal time for adrenal imaging is between 5 and 80 s after injection. © 2011 *Technical Radiology & Ultrasound*, Vol. 52, No. 3, 2011, pp 560-567.

82



83

TABLE I. Means and Standard Deviations of Perfusion Parameters Calculated From the Cortex, Medulla, and Renal Artery Regions of Interest

Parameters of perfusion	Cortex	Medulla	Renal artery
Peak (MPV)	75.8 ± 8.6 ^a	87.4 ± 8.0 ^b	108.2 ± 7.6 ^c
Time from injection to initial upstroke (s)	9.4 ± 1.2 ^a	7.8 ± 1.1 ^a	6.4 ± 0.7 ^a
Time from initial upstroke to peak (s)	2.8 ± 0.8 ^b	4.3 ± 1.2 ^b	3.8 ± 0.9 ^b
Upslope from initial upstroke to peak (MPV/s)	14.7 ± 3.9 ^a	15.2 ± 6.4 ^a	19.7 ± 7.5 ^a
Time from peak to initial refilling (s)	20.5 ± 1.1 ^a	18.3 ± 1.6 ^b	19.7 ± 1.1 ^a
Downslope from peak to refilling (MPV/s)	-2.2 ± 0.4 ^a	-2.7 ± 0.5 ^a	-2.8 ± 0.5 ^a
Time from initial refilling to refilling time (s)	6.9 ± 0.5 ^a	9.1 ± 1.3 ^b	8.8 ± 0.7 ^b
Upslope of the refilling (MPV/s)	3.4 ± 0.9 ^a	2.5 ± 0.7 ^b	3.2 ± 0.8 ^a
Downslope of the refilling (MPV/s)	-0.4 ± 0.1 ^a	-0.5 ± 0.1 ^a	-0.5 ± 0.1 ^a

Values in the same row having a different superscript letter differ significantly from each other.

84

Reproduction in Domestic Animals

Reprod. Dom. Anim. 98, 738–754 (2015), doi:10.1111/rda.12257
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Doppler and Contrast-Enhanced Ultrasonography of Testicles in Adult Domestic Felines

MBS de Brito¹, MAB Falcão¹, LN Cavalcanti², BR Usategui³, APB Simão⁴, MC Moura⁵, VT de Almeida⁶, RM Chedoke⁷, B Gomes⁸, L Fyfe⁹ and WR Bragança¹

¹Department of Animal Reproduction, College of Agricultural and Veterinary Sciences, São Paulo State University (Unesp), Jaboticabal, Brazil; ²School of Veterinary Medicine, University of São Paulo, São Paulo, Brazil

Abstract
The objective was to characterize the vascular pattern of testicular blood flow of adult cats, measuring the spectral velocity (SV) diastolic velocity (DV), systolic velocity (SV), and time flow (TF) parameters and compare them (mean) of the control and addition of these 12 characteristics. Forty-five adult cats were selected, and the echotexture, echogenicity, size, volume and weight of testicles were assessed via ultrasound. The Doppler wave indicated the blood flow and diameter of vascular vessels in common artery (CA), testis and RV and via contrast-enhanced ultrasonography determine the time for phase with a vascular and perfusion enhancement. Doppler Doppler parameters normal. Testicular artery was observed in the spermatic cord with constant pulse and increased echogenicity, showing uniform echotexture and echogenicity similar to the spleen (Oliveira and Travençolo 2005). Doppler ultrasound method allows to study the vascularization. Results of the spectral and time flow (TF) data for blood flow sequence or absence, direction and flow velocity (CA, testis and RV). In addition, vascular Doppler is routinely used to determine the blood flow of the vascular artery, the diagnosis of vascular diseases and the study of spermatogenesis (Poussard et al. 2005). In veterinary science, few studies are available with reports on the evaluation of testicular testicle (Poussard and Mollaret 2004) and dogs (Carvalho et al. 2012; Zaki et al. 2013), and few studies, with no reports on its use in the evaluation of cats. The interventional ultrasound contrast is a new technique in veterinary science. It uses contrast media of microgaseous inert structures, highly reflected by the apparatus that improves the color and spectral Doppler signal (King 2009). In humans, this technique has already been used for the diagnosis of diseases affecting the testis, when ultrasound findings are inconclusive, this technique is used to obtain a higher degree of diagnostic accuracy (Oliveira and Silva 2014). In animals, the first study on the use of the technique was performed in dogs (Oliveira et al. 2014). In the evaluation of studies with normal abnormalities, there are no studies on the technique in other species. Considering the novelty of using the Doppler and

85

VALORES DE NORMALIDADE

ULTRASSONOGRRAFIA EM CÃES E GATOS

Autores: Marcio Antonio Rossi Feliciano, Andréa Rêgo de Azeiteiro, Wilton Ricardo Riossano Viana

Editora: Medvet

em construção. Aguarde

86

AS TRÊS PRINCIPAIS APLICAÇÕES!

1. AVALIAR A FUNÇÃO TECIDUAL
2. ESTUDAR POSSÍVEIS CARACTERÍSTICAS DE MALIGNIDADE
3. RUPTURAS



87

AVALIAR A FUNÇÃO TECIDUAL



Laboratório de
Imaginologia Veterinária
FZEA-USP

88

Arg. Bras. Med. Vet. Zootec., v.67, n.6, p.1328-1332, 2015

Spleen evaluation using contrast enhanced ultrasonography and Doppler in dogs with subclinical ehrlichiosis

↓ wash-in – 5,31 seg

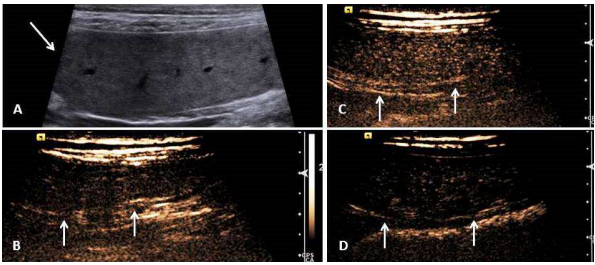
↓ pico de realce 18,56 seg

↓ wash-out 94,56 seg

13,2 seg

29,8 seg

5 a 7 min

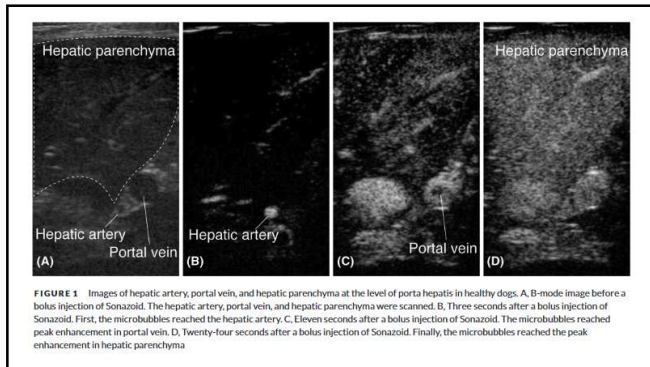


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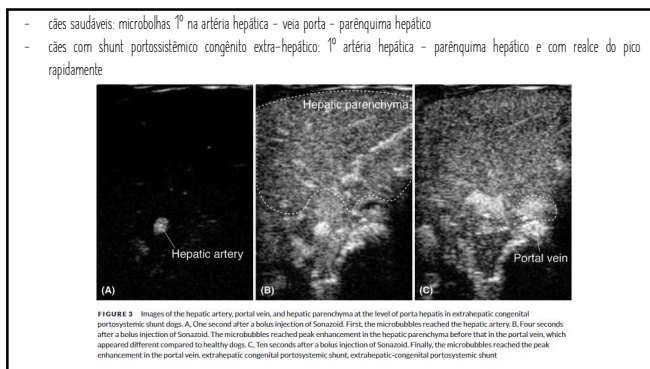


Extrahepatic-congenital portosystemic shunt is a vascular anomaly that connects the portal vein to the systemic circulation and leads to a change in hepatic microvascular perfusion. However, an assessment of hepatic microvascular perfusion is limited by conventional diagnostic modalities. The aim of this prospective, exploratory study was to assess hepatic microvascular perfusion in dogs with extrahepatic-congenital portosystemic shunt using contrast-enhanced ultrasonography (CEUS) using perflubron (SonoVue®). A total of 17 dogs were included, eight healthy dogs and nine with extrahepatic-congenital portosystemic shunt. The time-to-peak (TTP), rising time (RT), and rising rate (RR) in the hepatic artery, portal vein, and hepatic parenchyma, as well as the portal vein-to-hepatic parenchyma transit time (ΔHP-PV) measured from time-intensity curve on CEUS were compared between healthy and extrahepatic-congenital portosystemic shunt dogs. The RT of the hepatic artery in extrahepatic-congenital portosystemic shunt dogs was significantly earlier than in healthy dogs ($P = 0.0153$). The TTP and RT of the hepatic parenchyma were significantly earlier in extrahepatic-congenital portosystemic shunt dogs than in healthy dogs ($P = 0.0018$ and $P = 0.0024$, respectively). ΔHP-PV was significantly shorter in extrahepatic-congenital portosystemic shunt dogs than in healthy dogs ($P = 0.0018$). CEUS effectively revealed changes in hepatic microvascular perfusion including hepatic artery, portal vein and hepatic parenchyma simultaneously in extrahepatic-congenital portosystemic shunt dogs. Rapid hepatic artery and hepatic parenchyma enhancements may reflect a compensatory increase in hepatic artery blood flow (arterialization) caused by a decrease in portal vein blood flow and may be used as an additional diagnostic test to distinguish extrahepatic-congenital portosystemic shunt dogs from healthy dogs.

90

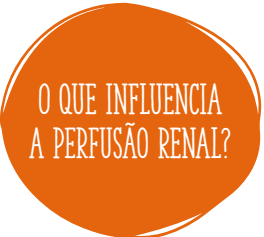


91



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93

Table 1. Mean and standard deviation of renal cortical perfusion parameters in dogs			
	Conscious group	TZM group	M group
Peak intensity (dB)	9.88 ± 2.65	9.57 ± 2.09	8.23 ± 2.55
Upslope (dB/sec)	2.25 ± 0.92	1.80 ± 1.01	1.10 ± 0.55 ^{a)}
Downslope (dB/sec)	-0.09 ± 0.02	-0.10 ± 0.01	-0.10 ± 0.02
TTP ₉₀ (sec)	10.33 ± 1.73	15.08 ± 4.28 ^{b)}	21.89 ± 6.7 ^{a,c)}
TTP ₁₀₀ (sec)	5.54 ± 0.97	7.98 ± 3.03	9.95 ± 2.25 ^{a)}
AUC (dBs)	277.19 ± 175.85	284.51 ± 158.07	185.21 ± 95.15

Data are expressed as mean ± SD (n=8). TZM, tiletamine-zolazepam-medetomidine; M, medetomidine; TTP₉₀, time to peak enhancement from contrast injection; TTP₁₀₀, time to peak enhancement from initial rise; AUC, area under the curve. a) $P < 0.05$ (Conscious group versus M group); b) $P < 0.05$ (Conscious group versus TZM group); c) $P < 0.05$ (TZM group versus M group).

Table 2. Mean and standard deviation of renal medullary perfusion parameters in dogs			
	Conscious group	TZM group	M group
Peak intensity (dB)	3.97 ± 1.72	4.13 ± 1.41	2.57 ± 1.09
Upslope (dB/sec)	0.53 ± 0.26	0.41 ± 0.21 ^{b)}	0.16 ± 0.08 ^{a,c)}
Downslope (dB/sec)	-0.04 ± 0.02	-0.05 ± 0.01	-0.04 ± 0.02
TTP ₉₀ (sec)	16.56 ± 2.69	23.69 ± 4.89 ^{b)}	35.80 ± 7.15 ^{a,c)}
TTP ₁₀₀ (sec)	8.49 ± 2.68	12.40 ± 4.23 ^{b)}	15.04 ± 3.07 ^{a)}
AUC (dBs)	131.57 ± 70.98	141.79 ± 96.25	53.72 ± 29.06 ^{a,c)}

Data are expressed as mean ± SD (n=8). TZM, tiletamine-zolazepam-medetomidine; M, medetomidine; TTP₉₀, time to peak enhancement from contrast injection; TTP₁₀₀, time to peak enhancement from initial rise; AUC, area under the curve. a) $P < 0.05$ (Conscious group versus M group); b) $P < 0.05$ (Conscious group versus TZM group); c) $P < 0.05$ (TZM group versus M group).

O QUE INFLUENCIA A PERFUSÃO RENAL?

ORIGINAL PAPER

Journal Article

Contrast enhanced ultrasonography of kidney in conscious and anesthetized beagle dogs

San-Yang CHEN^{1)*}, Wen-Chang KONG^{2)*}, Young-Won LEE³⁾ and He-Ang CHEN^{4)*}

94

Biomedical Research 2017; 28 (16): 7137-7141

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Quantitative analysis of contrast-enhanced ultrasound in the dog's acute renal failure.

Xiu Xia Fang^{*}, Bing Hui Fan, Ai-Qing Zhao, Ping Ping, Cui Yan

The Affiliated Hospital of Inner Mongolia Medical University, Inner Mongolia, PR China

Abstract

Purpose of present research was to prospectively test in dog model of ARF with hypothesis that the CEUS can quantitatively evaluate the perfusion changes of renal cortex in the early stage of the disease. The 15 healthy adult ARF dog models were injected intramuscularly with 50% glycerin into the hind legs followed by i.v. bolus 0.2 ml Sonovue in leg vein. Real time samples from dogs were collected with conventional and CEU examinations. The Blood serum Urea Nitrogen (BUN) and Serum Creatinine (SCr) level were tested along with kidney tissue sample of randomly selected dog. The converted parameters and blood test were compared using statistical software. Initial values of slope of Ascending curve (A), derived Peak Intensity (PI), Time to Peak (TTP), Area under Curve (AUC) were significantly high than the values before injection. In histopathological analysis no significant change was observed in 6 h after the injection of glycerin ($P > 0.05$) and might be seen after 24 h ($P < 0.05$). Quantitative analysis of CEU could monitor the changes of blood perfusion image of the renal cortex of the early renal function changes of dogs than SCr and BUN, has been more and more used in the diagnosis of clinical disease.

95

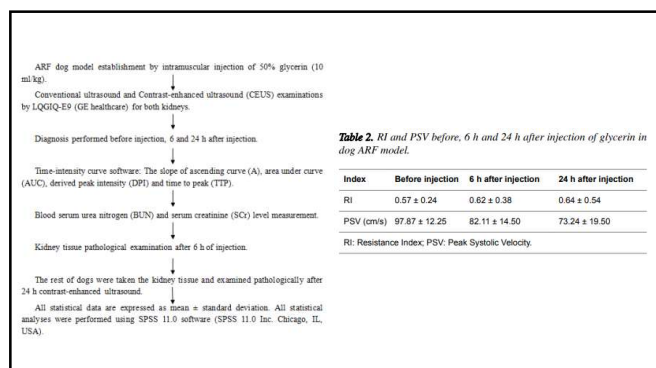


Table 2. RI and PSV before, 6 h and 24 h after injection of glycerin in dog ARF model.

Index	Before injection	6 h after injection	24 h after injection
RI	0.57 ± 0.24	0.62 ± 0.38	0.64 ± 0.54
PSV (cm/s)	97.87 ± 12.25	82.11 ± 14.50	73.24 ± 19.50

RI: Resistance Index; PSV: Peak Systolic Velocity.

96

Contrast enhancement ultrasound of renal perfusion in dogs with acute kidney injury

T. MANICOU, I. LIPPE, A. ROSS AND S. GUY

OBJECTIVE: To evaluate the efficacy of contrast-enhanced ultrasound to assess changes in renal perfusion in dogs with acute kidney injury.

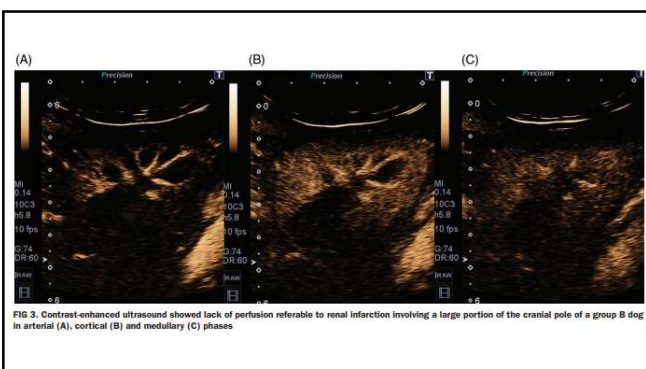
MATERIALS AND METHODS: The left kidney of each dog in two groups was examined using contrast-enhanced ultrasound: Group A consisted of 16 healthy dogs and Group B consisted of 12 dogs with acute kidney injury.

RESULTS: All dogs in Group A showed the same sequence of wash-in and wash-out. In Group B the distribution of contrast media showed a similar cortical phase to healthy dogs, but a faster time to maximal medullary enhancement. Group B showed increased medullary peak intensity and medullary area under the curve compared to Group A. Both qualitative and quantitative analyses showed vascular changes especially in the medulla, with more rapid medullary vascularisation and increased medullary perfusion. These results were interpreted as medullary congestion in dogs with acute kidney injury.

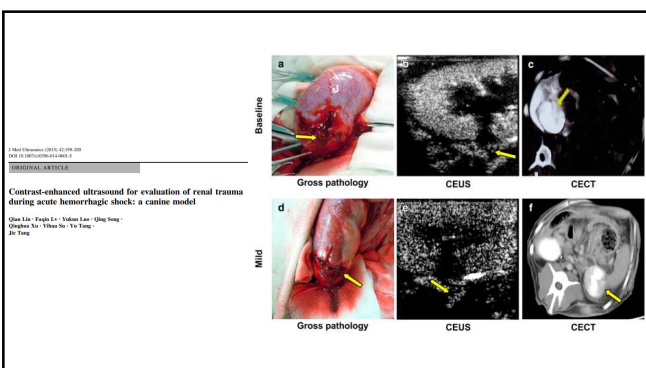
CLINICAL SIGNIFICANCE: Contrast-enhanced ultrasound represents an easy to perform, safe, and non-invasive method to detect changes in renal perfusion in dogs with acute kidney injury.

Journal of Small Animal Practice (2019) **60**, 471–476
DOI: 10.1111/jsap.13001

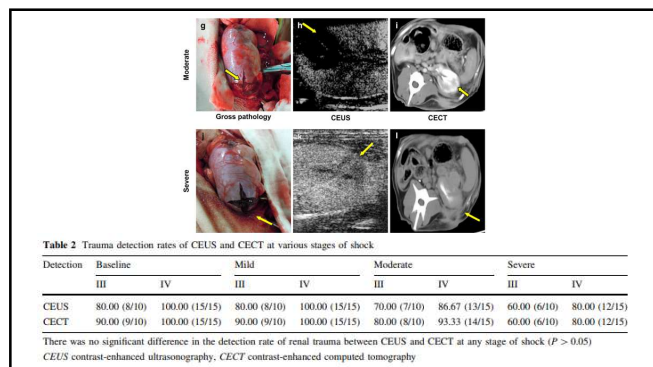
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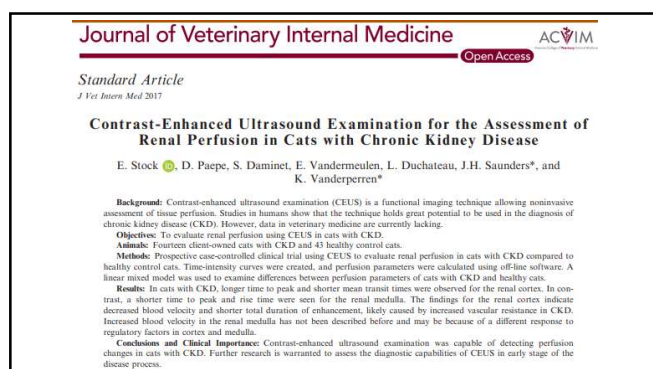
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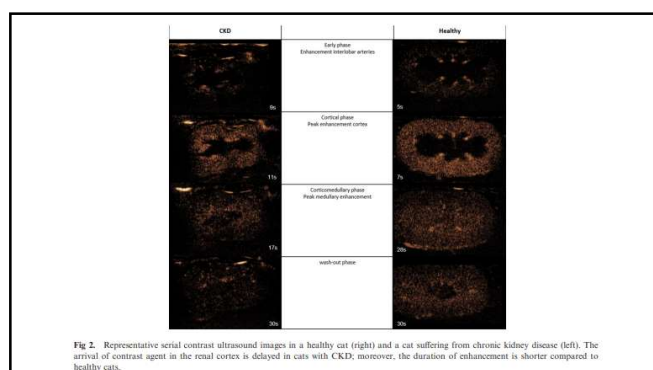
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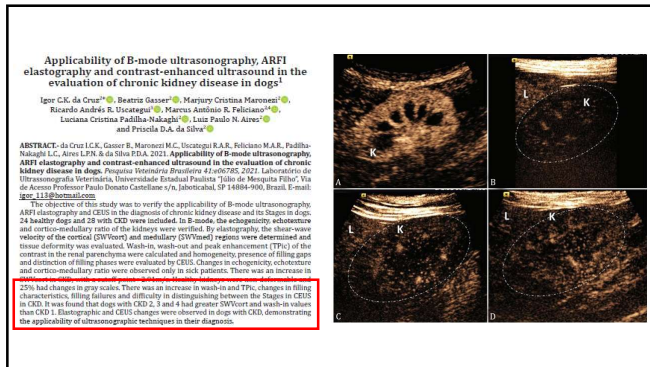
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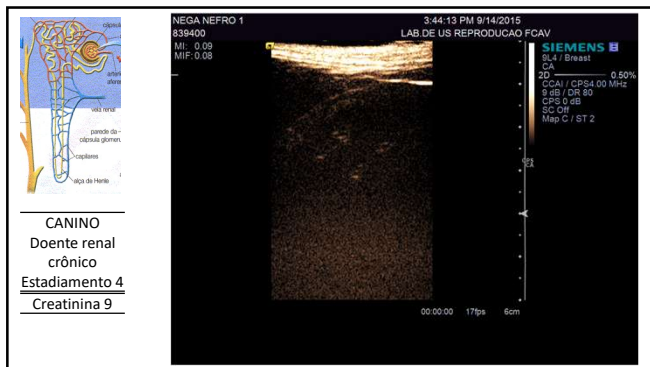
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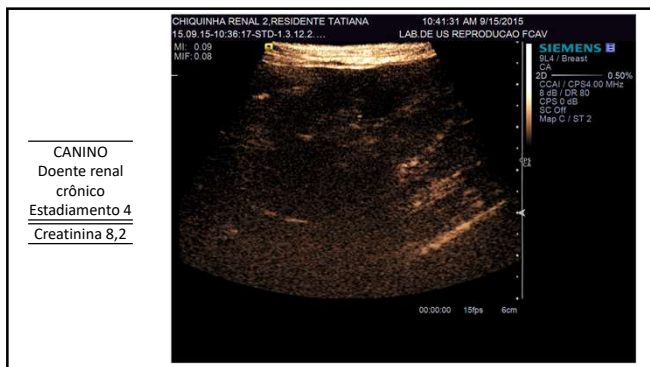
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103



104



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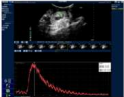
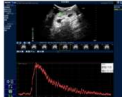
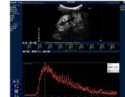
109

Rim

- 5 cães com anel constritor na artéria renal direita
- Comparado com creatinina sérica
- CEUS: Detectou mudanças da perfusão 4 a 7 semanas após o procedimento (↑ AUC, TP, PI)
- Creatinina: mudanças ocorreram em 11 semanas

Quantitative Evaluation of Contrast-Enhanced Ultrasonography in the Diagnosis of Chronic Ischemic Renal Disease in a Dog Model

YI Dong, Wengping Wang*, Jiajing Cao, Peili Fan, Xiyuan Lin

110

SCIENTIFIC REPORTS

Article | Open Access | Published: 02 June 2020

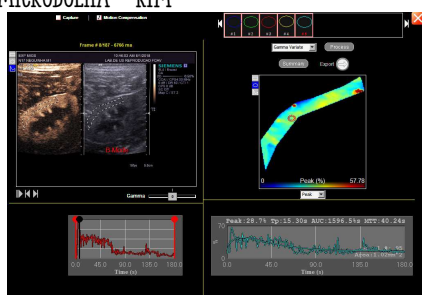
Clinical and ultrasound variables for early diagnosis of septic acute kidney injury in bitches with pyometra

Bianchi Gasser¹, Ricardo Andres Ramirez Usategui, Marjory Cristina Maroneti, Letícia Perani, Ana Paula Rodrigues Simões, Fernanda Martinato, Píscia Silva, Leandro Zuccolotto Crivellenti & Marcus Antônio Rossi Feliciano

infection was identified in 57% of cases with hypoperfusion and in 22% with inflammation, being an affection of multifactorial origin. Among the evaluated parameters, urinary protein/creatinine ratio >0.15, serum albumin <2.94 mg/dL, time-averaged minimum velocity <21.5 cm/s, renal length/aorta diameter ratio >5.93, pulsatility index >1.53, haematocrit <45%, time-averaged maximum velocity <45.7 cm/s, haemoglobin <16 g/dL, leukocytes >12.53 × 10³/uL, and cortical contrast peak intensity <69%, in the order of accuracy, are significant indicators of septic AKI with an accuracy >80%. Thus, AKI is a very prevalent

111

APLICAÇÃO MICROBOLHA - RIM



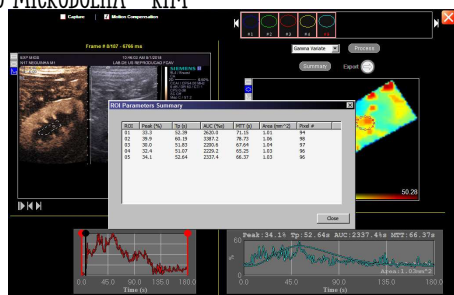
112

APLICAÇÃO MICROBOLHA - RIM



113

APLICAÇÃO MICROBOLHA - RIM



114

Veterinary Radiology & Ultrasound

WILEY

ORIGINAL RESEARCH

OPEN ACCESS

Contrast-Enhanced Voiding Urosonography for Diagnosis of Ectopic Ureters in Five Female Dogs

Georgia Trihinas | Lydimachos Papangelou | Pirokivi Papadopoulos

Companion Animal Clinic, Faculty of Veterinary Medicine, Aristotle University of Thessaloniki, Thessaloniki, Greece

Correspondence: Georgia Trihinas (trihinas@vetmed.upat.ac.gr)

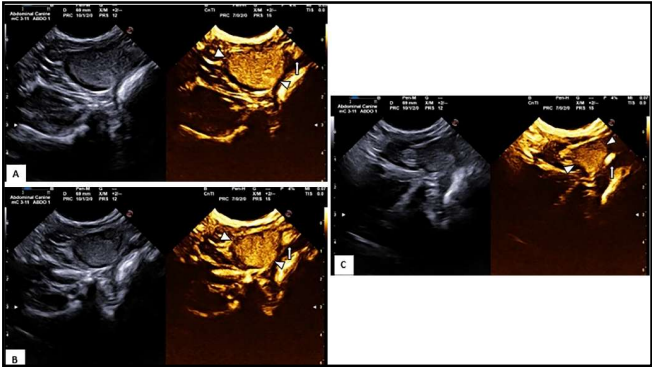
Received: 20 November 2025 | Received in final form: 10 July 2026 | Accepted: 11 August 2026

Keywords: canine | contrast-enhanced voiding urosonography (CEVUS) | ectopic ureter | ultrasonography | urinary incontinence | urosonography

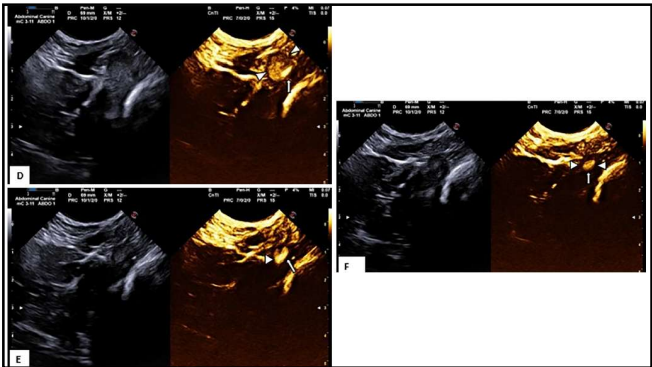
ABSTRACT

The aim of the study was to describe the implementation of contrast-enhanced voiding urosonography (CEVUS), a new, alternative, radiation-free imaging technique, for diagnosing ectopic ureters (EUs) in dogs. Five dogs were presented for evaluation of recurrent urinary tract infections and urinary incontinence. All dogs were bright and alert on presentation, and physical examination findings, complete blood count, and serum biochemistry results were within reference intervals. Plain radiographs and conventional ultrasonography did not reveal any appreciable changes. Following aseptic urethral catheterization, CEVUS was performed by infusing a second-generation microbubble-based ultrasound contrast agent into the urinary bladder. The contrast agent was observed in both ureters and pelvic/colic systems in cases one and five and in the left ureter and pelvic/colic system in cases two, three, and four. Displacement of the ureteral orifices was documented caudal to the bladder trigone in all dogs with EUs. Additionally, a stenosis associated with the left EU was identified in case three. These findings were consistent with vesicoureteral reflux secondary to EUs. The diagnosis was confirmed by radiographic cystography and/or computed tomography excretory urography (CTEU). CEVUS appears to be a useful, radiation-free imaging technique for evaluating urinary tract morphology and function in dogs. To the authors' knowledge, no previous studies have reported the clinical use of CEVUS for the diagnosis of EUs in dogs.

115



116



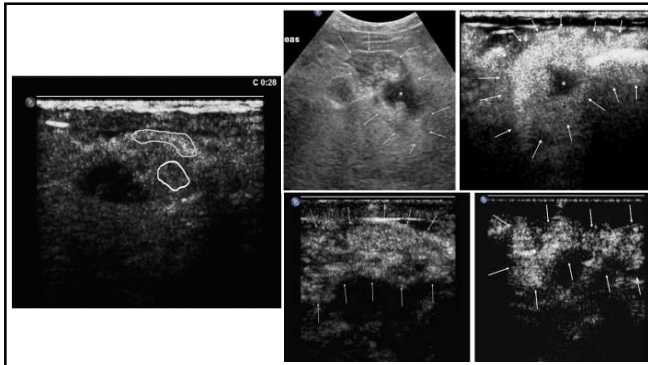
117

TABLE 2. Mean, Range, and Standard Deviation of Contrast Enhancement Parameters of the Pancreas in Healthy Dogs and Dogs with Pancreatitis ($n = 18$) ^a			
	Mean	Range	SD
Mean peak time healthy (s)	18.67	11.4–31.5	± 5.50
Mean peak time affected (s)	13.06	4.8–22.3	± 4.49
Mean peak time affected (decibels)	15.36	6.0–38	± 9.2
Mean wash-in time to peak healthy (s)	8.6	5–21.7	± 3.73
Mean wash in time to peak affected (s)	5.3	0.97	± 2.6
Mean wash in time to peak affected (decibels)	9.3	1–25.7	± 9.2
Wash-in time healthy (s)	39.1	18–68	± 3.8
Wash-in time affected (s)	7.3	2–16.3	± 4.5
Wash-in time affected (decibels)	7.3	1.5–13	± 4.61
Mean peak intensity (dB) healthy	104.7	5.7–121	± 59.3
Mean peak intensity (dB) affected	104.6 ^b	7.69–193	± 66.1
Mean peak intensity (dB) affected (decibels)	61.95	6.88–122	± 49.2
Mean pixel intensity (dB) healthy	24.3	14–40.9	± 13.8
Mean pixel intensity (dB) affected	99.6 ^b	38.7–187.7	± 55.1
Mean pixel intensity (dB) affected (decibels)	66.8	28–134.7	± 44.2

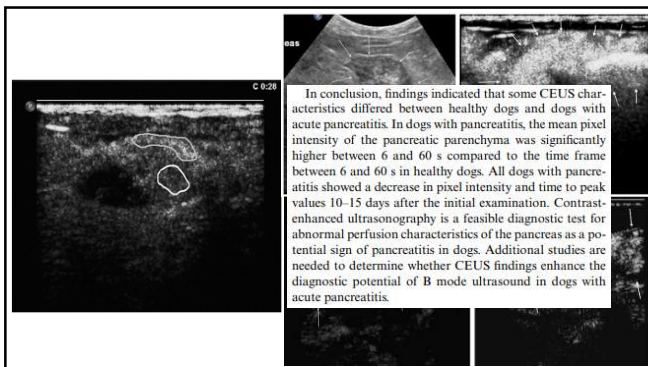
^aIn dogs with pancreatitis, the mean pixel intensity and peak intensity of the pancreatic parenchyma was statistically significantly higher ($P = 0.05$) compared to healthy dogs. All other parameters showed a decrease in peak intensity 10–15 days after the initial diagnosis ($P < 0.01$) and their time to peak values were prolonged compared to the healthy dogs. Data from the current study reported are for CSES for diagnostic pancreatitis, pancreatic necrosis, and disease-worsening laboratory findings. CSES = American College of Veterinary Radiology.

Pericarditis is the most frequent disease affecting the viscerae pancreas in dogs and stable diagnostic indicators for pericarditis that accompany it lacking. Contrast-enhanced ultrasonography (CEUS) represents direct perfusion as well as organ blood flow parameters. Observation of this parameter can detect early wave to contrast perfusion in the microcirculation and assessment of the pancreas in healthy dogs and in patients with pancreatitis, abdominal distention, and fluid ascites in dogs. A CEUS study of the pancreas and portal vein in dogs with pancreatitis showed a lower peak intensity and peak intensity to peak intensity difference in time in the intensity curves. Perfusion parameters were compared between healthy and affected dogs. In this study, pancreatitis, mean peak and peak intensity of the pancreatic parenchyma were significantly lower ($P < 0.01$) in dogs with pancreatitis compared to healthy dogs. The time to peak intensity in dogs with acute pancreatitis compared to healthy dogs was greater and the time to peak intensity in dogs with chronic pancreatitis compared to healthy dogs. All other parameters showed a decrease in peak intensity 10–15 days after the initial diagnosis ($P < 0.01$) and their time to peak values were prolonged compared to the healthy dogs. Data from the current study reported are for CSES for diagnostic pancreatitis, pancreatic necrosis, and disease-worsening laboratory findings. CSES = American College of Veterinary Radiology.

Key words: canine, contrast-enhanced ultrasound, pancreatitis.



121



122

Journal of Veterinary Internal Medicine

J Vet Intern Med 2015;29:71–78

Quantitative Contrast-enhanced Ultrasonographic Assessment of Naturally Occurring Pancreatitis in Dogs

S.Y. Lim, K. Nakamura, K. Morishita, N. Sasaki, M. Murakami, T. Osuga, N. Yokoyama, H. Ohta, M. Yamasaki, and M. Takiguchi

Background: Quantitative contrast-enhanced ultrasonography (CEUS) can detect pancreatic perfusion changes in experimentally induced canine pancreatitis. However, its usefulness in detecting perfusion changes in naturally occurring pancreatitis is unclear.

Hypothesis/Objectives: To determine the feasibility of using CEUS to detect pancreatic and duodenal perfusion changes in naturally occurring canine pancreatitis.

Animals: Twenty-three client-owned dogs with pancreatitis, 12 healthy control dogs.

Methods: Dogs diagnosed with pancreatitis were prospectively included. CEUS of the pancreas and duodenum were performed. Time-intensity curves were created from regions of interest in the pancreas and duodenum. Five perfusion parameters were obtained for statistical analyses: time to initial up-slope, peak time (Tp), time to wash-out (TTW), peak intensity (PI), and area under the curve (AUC).

Results: For the pancreas, Tp of the pancreatitis group was prolonged when compared to controls (62 ± 11 seconds versus 39 ± 13 seconds; $P < .001$). TTW also was prolonged but not significantly (268 ± 69 seconds versus 228 ± 47 seconds; $P = .47$). PI and AUC were increased when compared to controls (95 ± 15 versus 78 ± 13 MPV; $P = .009$ and $14,900 \pm 1,400$ versus $11,000 \pm 2,800$ MPVs; $P = .013$, respectively). For the duodenum, PI and AUC were significantly increased in the pancreatitis group when compared to controls.

Conclusion and Clinical Importance: Contrast-enhanced ultrasonography can detect pancreatic perfusion changes in naturally occurring canine pancreatitis characterized by delayed peak with prolonged hyperechoic enhancement of the pancreas on CEUS. Additionally, duodenal perfusion changes secondary to pancreatitis were observed.

Key words: Contrast-ultrasound; Inflammation; Pancreas; Perfusion.

123

Table 2. Mean $\pm$ SD of pancreatic and duodenal perfusion parameters measured from TIC of dogs from pancreatitis and control group.

Measured Parameters	Pancreas			Duodenum		
	Pancreatitis Group (n = 20)	Control Group (n = 12)	P-Value ^a	Pancreatitis Group (n = 18)	Control Group (n = 9)	P-Value ^a
TTU (seconds)	10 $\pm$ 4	10 $\pm$ 4	1.00	21 $\pm$ 4	22 $\pm$ 3	1.00
Tp (seconds)	62 $\pm$ 11	39 $\pm$ 13	<.001	61 $\pm$ 9	50 $\pm$ 15	.13
PI (MPV)	95 $\pm$ 10	78 $\pm$ 17	.17	94 $\pm$ 14	74 $\pm$ 10	.005
AUC (MPV*s)	14,900 $\pm$ 3,400	11,000 $\pm$ 2,800	.013	14,000 $\pm$ 4,000	9,700 $\pm$ 2,000	.045

TTU, time to initial up-slope; Tp, peak time; TTW, time to wash-out; MPV, mean pixel value; PI, peak intensity; AUC, area under the curve.

^aBased on the comparison of pancreatitis and control group using Student's *t*-test and Bonferroni correction to account for multiple comparisons.

Table 3. Area under the ROC curves (AUROC) and their 95% confidence intervals (95% CI) for the pancreatic perfusion parameters.

Measured Parameters	AUROC (95% CI)	Cut-off Value	Sensitivity (95% CI) ^a	Specificity (95% CI) ^a
TTU (seconds)	0.50 (0.29-0.71)	≥ 18	65 (43-82)	50 (25-75)
Tp (seconds)	0.92 (0.82-1.00)	≥ 48	90 (70-97)	83 (55-95)
TTW (seconds)	0.64 (0.44-0.83)	≥ 50	65 (43-82)	67 (39-90)
PI (MPV)	0.82 (0.67-0.97)	≥ 87	80 (58-92)	75 (47-91)
AUC (MPV*s)	0.81 (0.65-0.96)	$\geq 13,700$	70 (48-85)	83 (55-95)

TTU, time to initial up-slope; Tp, peak time; TTW, time to wash-out; MPV, mean pixel value; PI, peak intensity; AUC, area under the curve.

^aNumbers expressed as percentages.

124

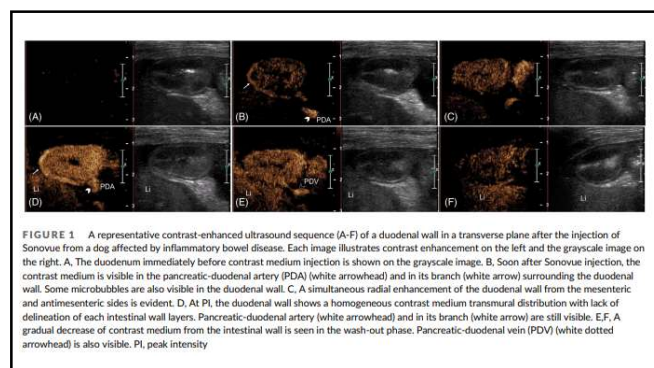
STANDARD ARTICLE Journal of Veterinary Internal Medicine Contrast-enhanced ultrasonography in dogs with inflammatory bowel disease Nikolaus Linta Pascale Pey Marco Baron Teubler Marco Petosa Manuel Földi Gabriele Bettini Maria Cipone Alessia Piazza			
Perfusion variable	Control group (n = 10)	IBD group (n = 36)	P value
AT (s)	10.86 $\pm$ 2.52	11.25 $\pm$ 4.86	.82
TPHs (s)	15.48 $\pm$ 2.91	15.96 $\pm$ 6.05	.82
TPW (s)	4.49 $\pm$ 0.95	5.22 $\pm$ 1.45	.16
PI (au)	3.85 [3.04-4.93]	5.10 [4.03-5.56]	.03
MTT (s)	9.15 [6.82-12.53]	10.63 [8.50-21.29]	.14
AUC (au*s)	47.63 [27.68-62.15]	63.62 [5.31-212.20]	.03
W (au/s)	6.00 [2.01-1.28]	6.99 [2.14-2.92]	.5

Note: Normal and not normal distributed data are given as mean $\pm$ SD or median and range (interquartile range), respectively.

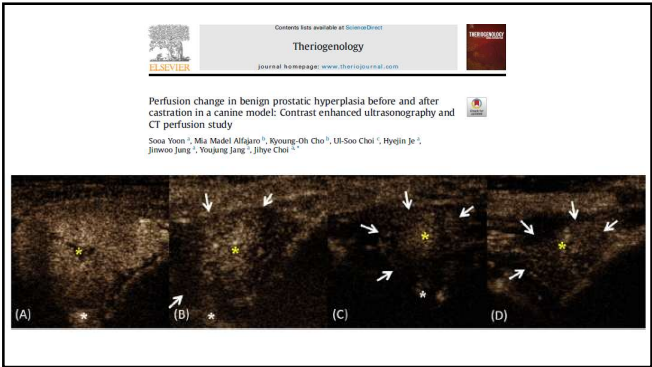
Abbreviations: AT, arrival time; AUC, area under the curve; IBD, inflammatory bowel disease; MTT, mean transit time; n, number of dogs; PI, peak intensity; TPHs, time to peak from injection; TPW, time to peak from initial rise; W, wash-in rate.

 Abstract **Background:** Contrast-enhanced ultrasonography (CEUS) is used to evaluate vascularity of the gastrointestinal wall in neoplastic and inflammatory diseases. **Objective:** To assess the feasibility of CEUS for the evaluation of duodenal perfusion in dogs with inflammatory bowel disease (IBD). **Animals:** Forty-two dogs with IBD and 20 clinically healthy dogs. **Methods:** All CEUS studies of the duodenum were analyzed to obtain time-intensity curves and perfusion parameters. The procedure was repeated in 12 IBD dogs 2 months after a standardized treatment. **Results:** On CEUS, the duodenal wall showed a typical perfusion pattern characterized by a radial and simultaneous enhancement of the wall in all dogs. On qualitative assessment, no differences were observed in contrast medium distribution between healthy and affected dogs, or between dogs with IBD before and after treatment. Peak intensity (PI) and area under the curve (AUC) significantly differed between healthy (PI = 3.58 arbitrary units [au]; 1.86-4.93 au) and IBD (PI = 5.10 au [4.03-5.56 au] and AUC = 47.63 au seconds [27.68-62.15]) and affected dogs (PI = 5.10 au [4.03-5.56 au] and AUC = 63.62 au [5.31-212.20 au]; *P* = .03 and .03, respectively). No significant differences were found for the perfusion parameters before and after treatment. **Conclusions and Clinical Importance:** We showed that CEUS allows discrimination between IBD affected dogs and healthy dogs by evaluation of time-intensity curves, but did not provide useful information for monitoring therapeutic response. The qualitative assessment identified no significant differences between healthy and affected dogs, or between dogs before and after treatment. |

125



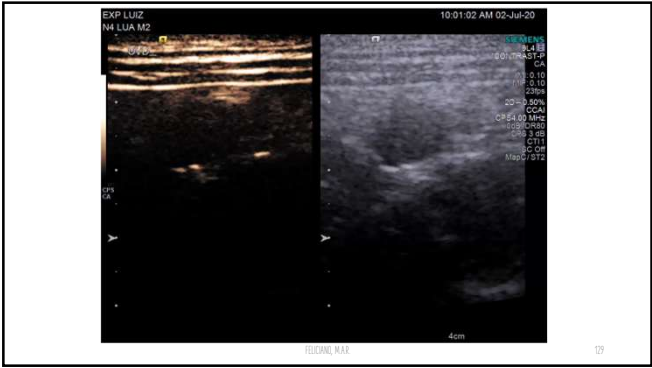
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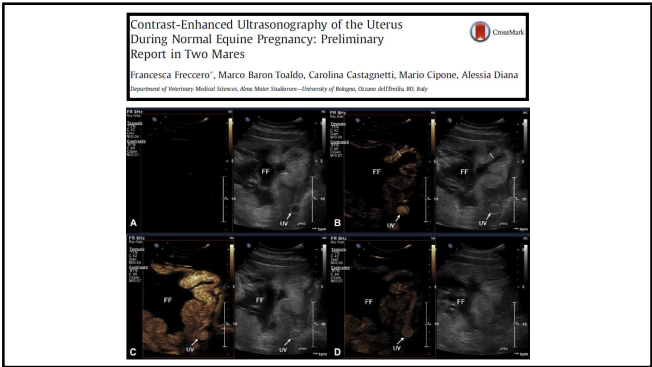
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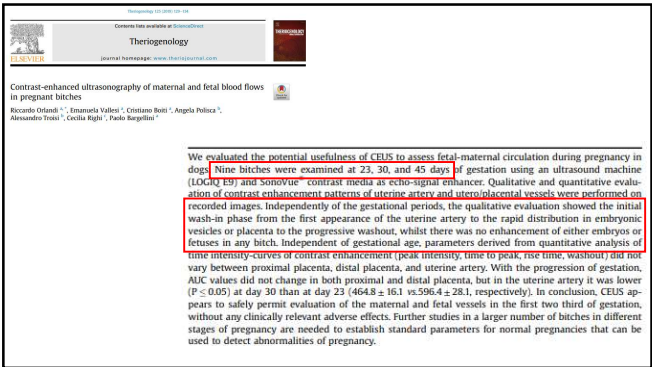
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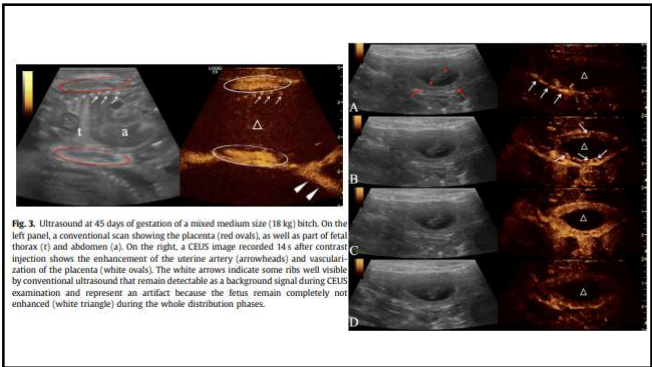
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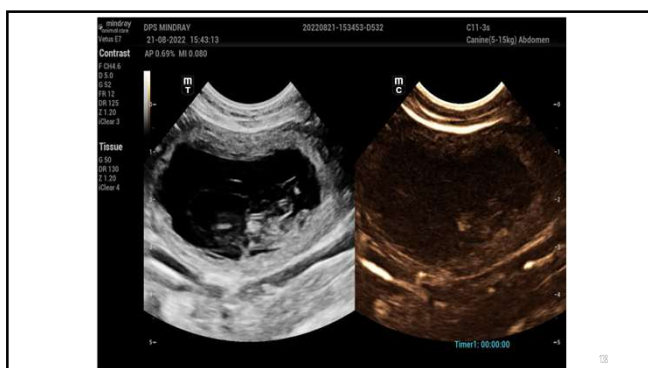
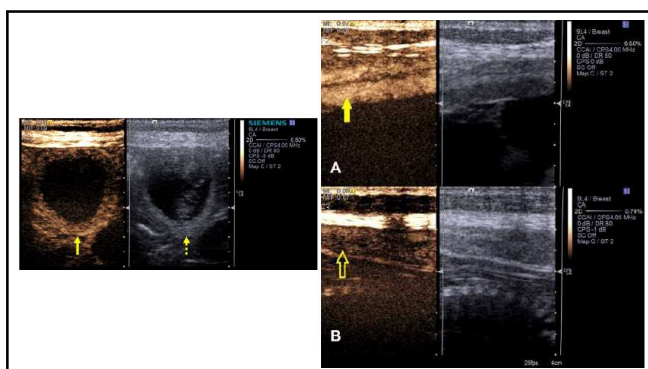
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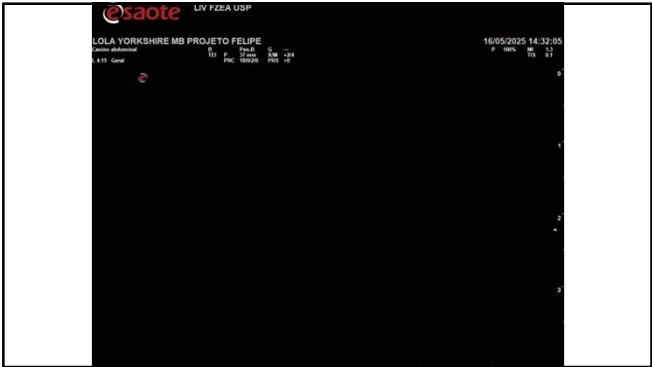


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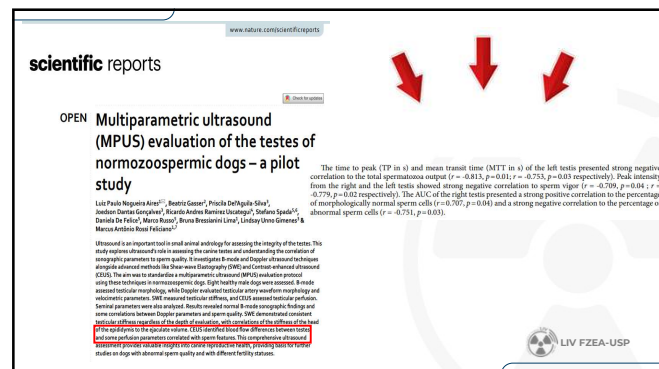


Tabela 9. Valores de média $\pm$ desvio padrão dos parâmetros da CEUS na avaliação do corpo lúteo de cadelas saudáveis aos 25, 45 e 58 dias de gestação.

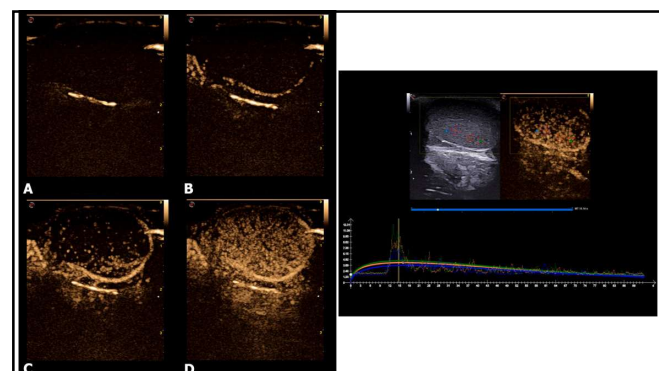
Momentos	PEAK	TP	MITT	AUC	PIXEL
M1	17.75 $\pm$ 6.66	21.83 $\pm$ 10.86 ^a	38.10 $\pm$ 14.62	793.68 $\pm$ 468.80 ^a	93.00 $\pm$ 32.06 ^a
M2	18.51 $\pm$ 5.66	19.09 $\pm$ 10.53 ^b	31.32 $\pm$ 10.53	571.86 $\pm$ 288.48 ^b	75.32 $\pm$ 41.91 ^b
M3	16.15 $\pm$ 4.47	15.29 $\pm$ 5.62 ^c	35.57 $\pm$ 14.53	486.71 $\pm$ 243.84 ^b	280.82 $\pm$ 18.85 ^{ab}
Valor de P	0.206	< 0.001 ^a	0.053	0.004 ^a	0.007 ^a

Peak: Pico de intensidade em pixels, Tp: tempo para o pico de intensidade em segundos, mitt: tempo médio de transmissão, auc: área sob a curva, pixels: inclinação da curva de entrada em pixels. ^aEstatisticamente significativo (P < 0,05). Letras minúsculas diferentes indicam diferença estatística entre os momentos.

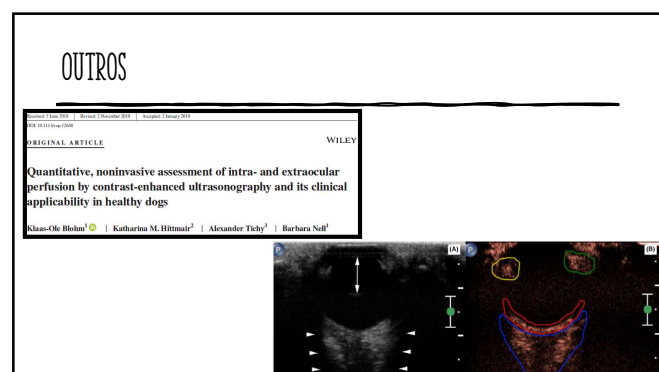
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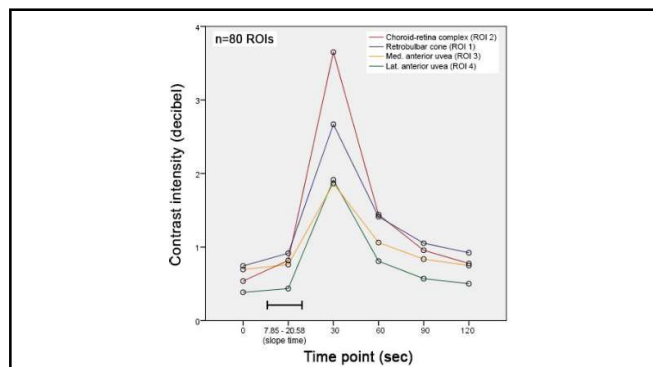
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143



144



145

NOTE Internal Medicine

Contrast-enhanced ultrasonographic findings in three dogs with lung lobe torsion

Domenico CAIVANO¹*, Francesco BIRETTONI¹, Antonello BUFALARI¹, Valentina DE MONTE¹, Giovanni ANGELI¹, Maria Elena GIORGI¹, Valentina PATATA¹ and Francesco PORCIELLO¹

¹Department of Veterinary Medicine, University of Perugia, Via San Costanzo, 4–06126 Perugia, Italy

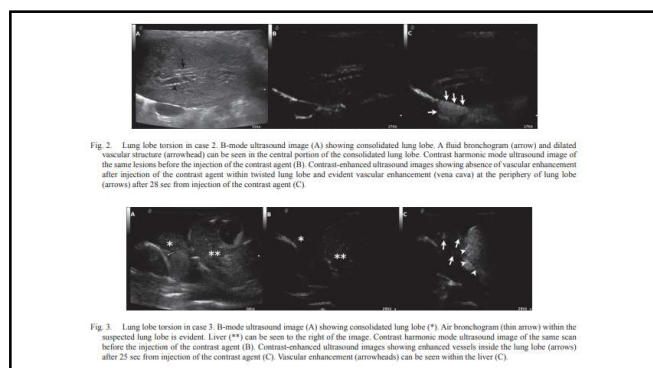
(Received 9 July 2015/Accepted 9 October 2015/Published online in J-STAGE 24 October 2015)

ABSTRACT Lung lobe torsion is rare but life-threatening condition in the dog. Thoracic radiographs and conventional ultrasonography cannot be conclusive for the diagnosis, and computed tomography is useful but is limited by cost and availability. This report describes the findings of contrast-enhanced ultrasonography in 3 dogs with lung lobe torsion. Contrast-enhanced ultrasonography showed the absence or reduction of pulmonary vascularization secondary to twisting of the lung lobe around its bronchovascular pedicle in all three dogs. Moreover, contrast-enhanced ultrasonography distinguished partial pulmonary atelectasis from a lung lobe torsion. These preliminary results suggest that contrast-enhanced ultrasonography can improve the accuracy of conventional ultrasonography for detection of pulmonary blood flow compromise in dogs with lung lobe torsion.

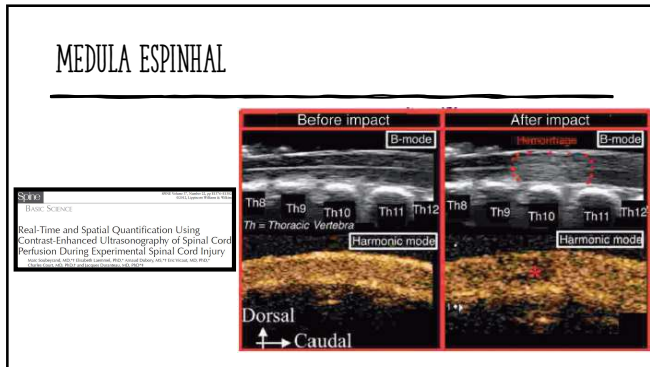
KEY WORDS: canine, CEUS, contrast-enhanced ultrasonography, lung lobe torsion

doi: 10.1292/jvms.15-0417, *J. Vet. Med. Sci.* 78(3): 427–430, 2016

146



147



148



149

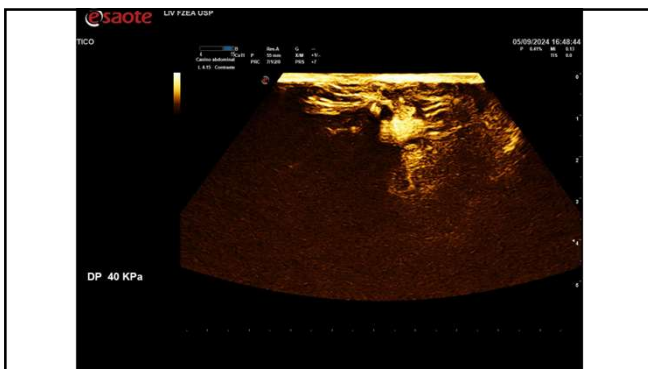


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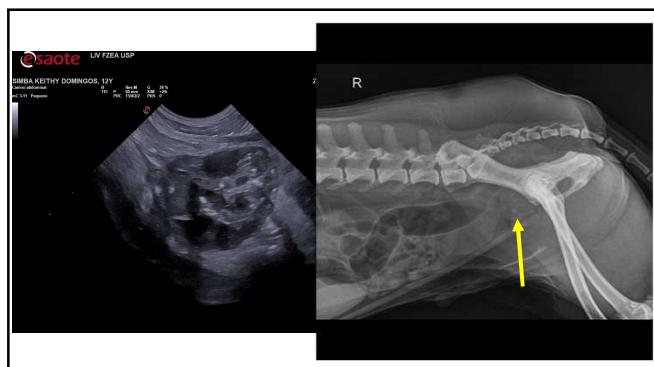
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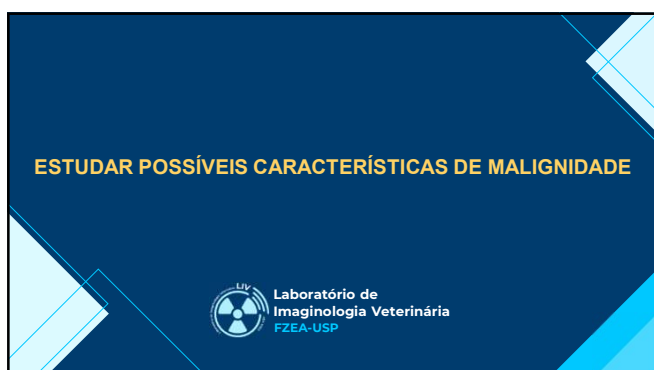
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157



158



159

Rev. Bras. Cancerol., 1994; 40(3):170-177

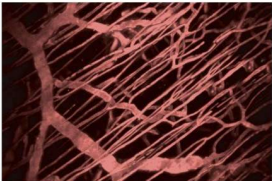
Angiogênese tumoral

JOSÉ AUGUSTO ASSUMPTÃO CRESPO RIBEIRO*

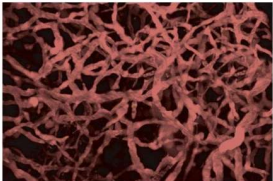
O QUE PRECISAMOS ENTENDER 1º!?

1. A POPULAÇÃO DE CÉLULAS NEOPLÁSICAS E A POPULAÇÃO DE CÉLULAS ENDOTELIAIS CAPILARES DE UM TUMOR CONSTITUEM UM **VERDADEIRO ECOSISTEMA**
2. CRIAÇÃO DE **CANALIZAÇÃO** - COMUNICAÇÃO COM REDE VASCULAR PRÉ-EXISTENTE
3. **FATORES ANGIOGÊNICOS** - PRODUÇÃO DE ENZIMAS, MIGRAÇÃO E PROLIFERAÇÃO DAS CÉLULAS
4. ANGIOGÊNESE É CONSTANTE - PERMANECE ACONTECENDO ATÉ O TUMOR SER ELIMINADO OU CULMINAR COM A MORTE DO HOSPEDEIRO - **VASOS ATÍPICOS**

160



normal tissue

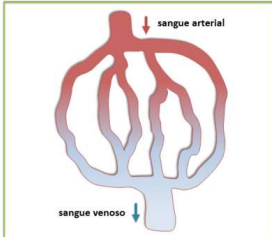


tumor

VASOS ATÍPICOS

161

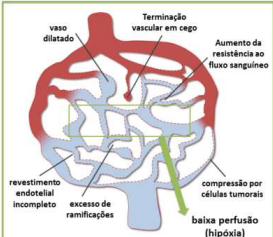
(a) vasculatura normal



sangue arterial

sangue venoso

(b) vasculatura tumoral



vaso dilatado

Terminação vascular em cego

Aumento da resistência ao fluxo sanguíneo

revestimento endotelial incompleto

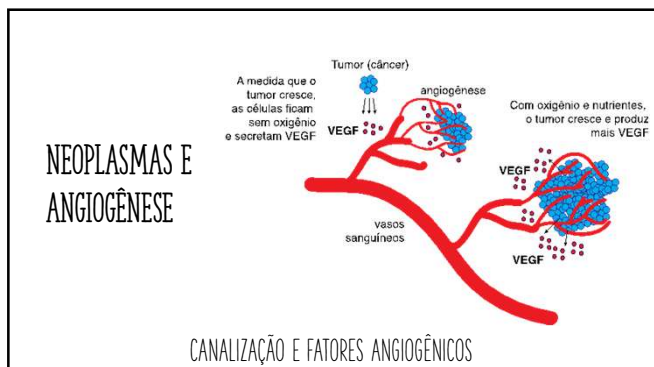
excesso de ramificações

compressão por células tumorais

baixa perfusão (hipóxia)

ESTRUTURA VASCULAR

162



163

¡Cuidado!

The 15 malignancies were comprised of 11 hepatocellular carcinomas, one combined hepatocellular and cholangiocellular carcinoma, one carcinoma, one hemangiosarcoma, and one osteosarcoma. Needle aspirates were taken with ultrasound guidance in the other eight lesions with six suspected hemangiosarcomas, one lymphoma, and one nodular hyperplasia. Finally, 16 lesions were diagnosed as malignant tumors, and six lesions were diagnosed as benign lesions (Table 1).

All six benign lesions were isoechic to the surrounding normal liver during the parenchymal phase. On the other hand, 15 of the 16 lesions with a confirmed diagnosis of malignancy were hypoechic (Fig. 2). This finding was significantly ($P<0.01$) correlated with malignancy with an accuracy of 93.3% (95% confidence interval [CI], 78.5–95.5%), a sensitivity of 93.3% (95% CI, 82.8–93.8%), a specificity of 100% (95% CI, 70.7–100%), a positive predictive value of 100% (95% CI, 88.3–100%), and a negative predictive value of 85.7% (95% CI, 66.6–95.7%). Additionally, five of the six benign lesions were isoechic during the arterial phase. Among the 15 malignant lesions, conversely, only one lesion was isoechic, 11 lesions were hyperechic, and three lesions were hypoechic. Hyperechogenicity or hypoechogenicity at the arterial phase was also significantly related to malignancy ($P<0.01$) with an accuracy of 98.2% (95% CI, 72.7–95.2%), a sensitivity of 93.3% (95% CI, 80.9–98.1%), a specificity of 93.3% (95% CI, 52.2–95.2%), a positive predictive value of 93.3% (95%

There were some limitations in this study. First, the number of patients with benign nodules was small. Therefore, there were large confidence intervals for the specificity and negative predictive value for differentiation between malignant and benign liver lesions. Second, only one hemangiosarcoma was diagnosed histologically. Third, the criteria for diagnosis were not applied prospectively. A prospective study is needed to confirm the accuracy for differential diagnosis of hepatic nodules.

1. Hiperplasia?
2. Hematoma?
3. E outras lesões com áreas de necrose ou alterações vasculares?

164

1. Como funciona a angiogênese e vascularização tumoral?

Mas nem sempre é assim!

vascular em

aumento da resistência ao fluxo sanguíneo

compressão por células tumorais

hipoxia

excesso de células tumorais

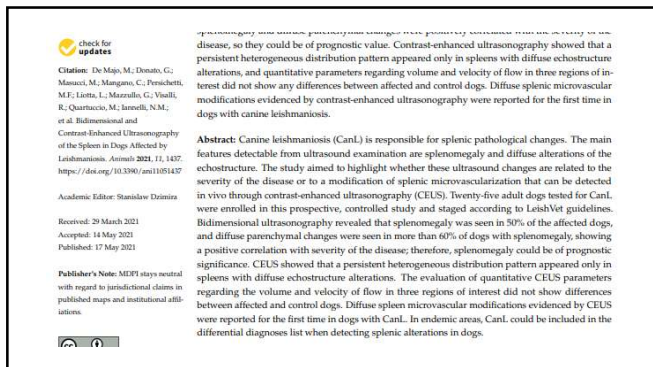
aumento da permeabilidade

LIV FZEA-USP

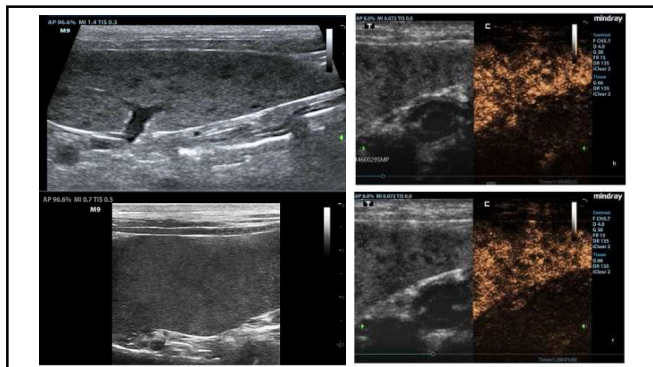
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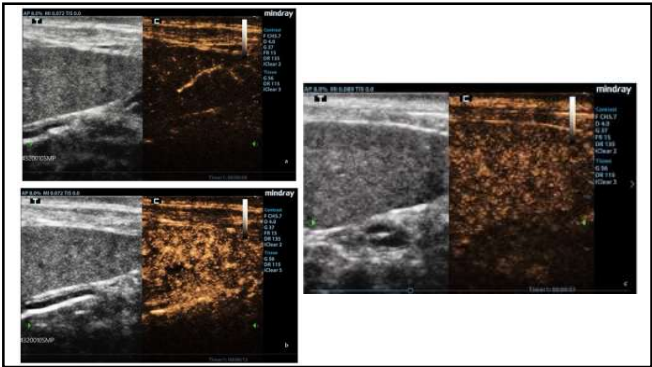
166



167



168



169

Rossi et al. [77] studied 18 dogs and cats with 8 different types of malignant lesions and found that although the wash-in and peak phases showed some variations, all of them had hypo-enhanced wash-out phases. These results were confirmed in two other studies with 29 [78] and 16 [75] dogs, which included malignant lesions not observed in the original study: osteosarcoma, leiomyosarcoma [75], and plasmacytoma [78].

When looking at the characteristics of individual malignant lesions, malignant lymphomas were found to have the highest peak-intensity and AUC while also presenting the fastest wash-in and wash-out phases [56], while lympho-sarcomas showed only early wash-in and wash-out phases [77]. Hemangiosarcoma is the splenic neoplasia that has proven to be the hardest to diagnose definitively, presenting challenges even for histopathology. CEUS has proven unsuccessful in differentiating malignant hemangiosarcoma from a benign hematoma [76], and it has been suggested that the well-vascularized tissue present in areas of hemorrhage may also exist in areas of high cell proliferation, as in a hemangiosarcoma [104]. This maybe the reason why some hemangiosarcomas, in contrast with other malignant lesions, show hyperenhancement [76,78]. This could also present an explanation as to why aberrant vessels with corresponding high peak intensities have been found in hemangiosarcomas [74]. One study looking at five cases of malignant splenic lesions, of which there were hemangiosarcomas, found that although hypo-enhancement in the wash-out phase could not differentiate malignant from benign lesions, the presence of tortuous vessels feeding the lesion could [74]. This reinforces the possibility that differentiation between hematoma and hemangiosarcoma should focus on vascular CEUS patterns, a reflection of how the lesions are perfused [105], as opposed to contrast enhancement in any phase.

170

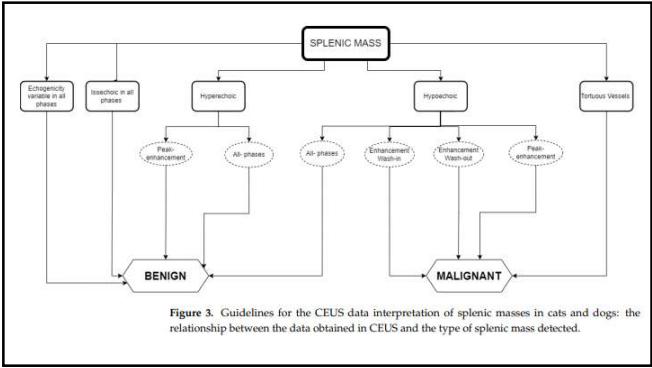
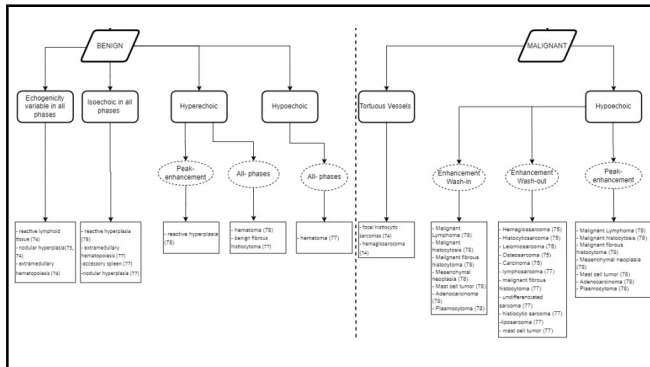


Figure 3. Guidelines for the CEUS data interpretation of splenic masses in cats and dogs: the relationship between the data obtained in CEUS and the type of splenic mass detected.

171



172

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Contrast Harmonic Imaging Characterization of Canine Splenic Lesions

S. Olfert, M. Dennerle, E. Rieff, B. Hauser, V. Poirier, N. Siebeck, M. Roos, B. Kazar-Hedz

Results: Cytology or histology identified 27 benign (hyperplasia, extramedullary hematopoiesis, hematoma) and 29 malignant (hemangiosarcoma, malignant lymphoma, malignant histiocytosis, mesenchymal tumors without classification, mast cell tumors, and others) lesions and 4 normal spleens. Except for 1 benign nodule, extensive to moderate hypoechoic was only seen in malignant lesions during wash-in, at peak enhancement, and during wash-out ($P = .0001$, odds ratios: 37.9 [95% CI 4.5–316.5], 66.4 [95% CI 8.0–551.1], and 36.9 [95% CI 4.4–308.4]). Although all but 1 benign lesion enhanced well and were mildly hypo-, iso-, or hyperechoic in comparison with the normal spleen during all blood pool phases, marked enhancement occurred both in benign as well as in malignant splenic lesions. Quantitative perfusion values did not differ significantly between benign and malignant lesions.

Conclusions and Clinical Importance: Moderate to extensive hypoechoic clearly identifies canine splenic malignant lesions. In nodules with marked enhancement, contrast harmonic ultrasound is of limited value and histology is needed.

173

173

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Contrast Harmonic Imaging Characterization of Canine Splenic Lesions

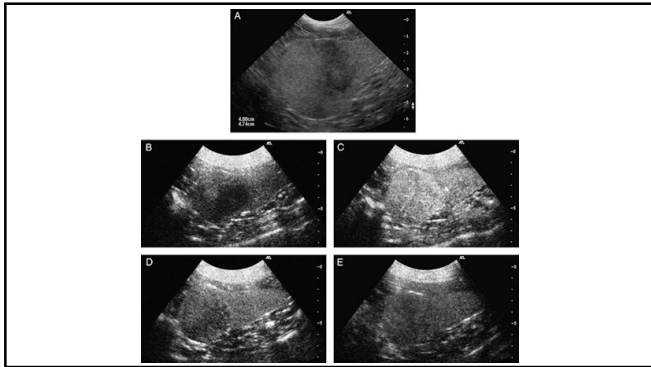
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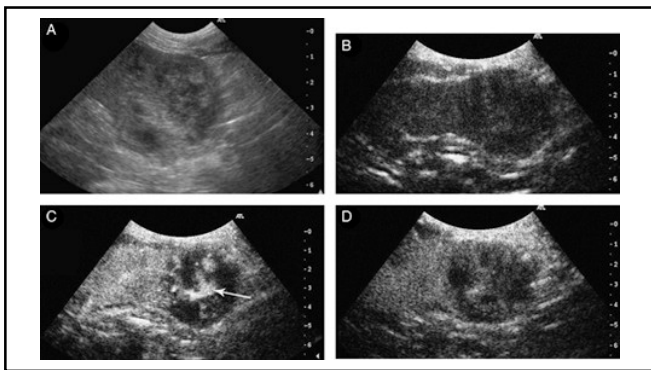
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174

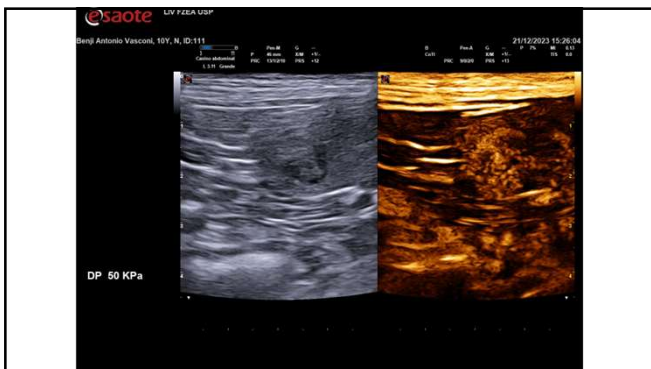
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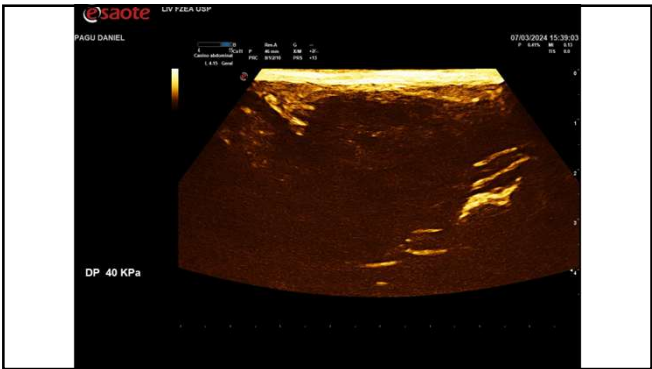
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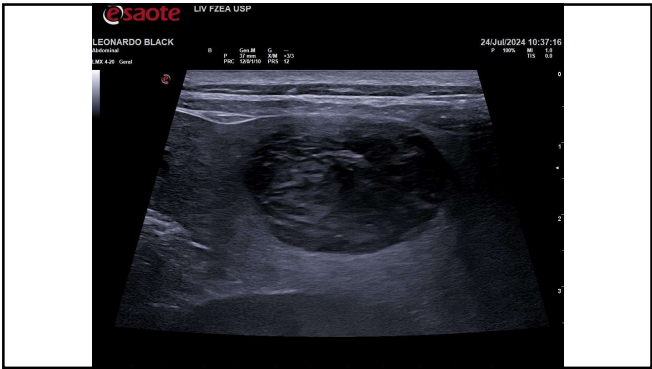
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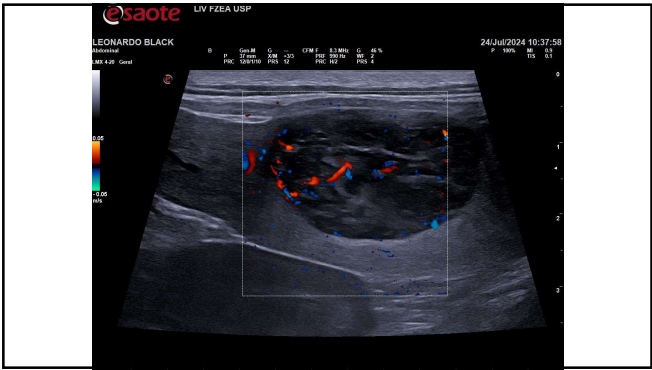
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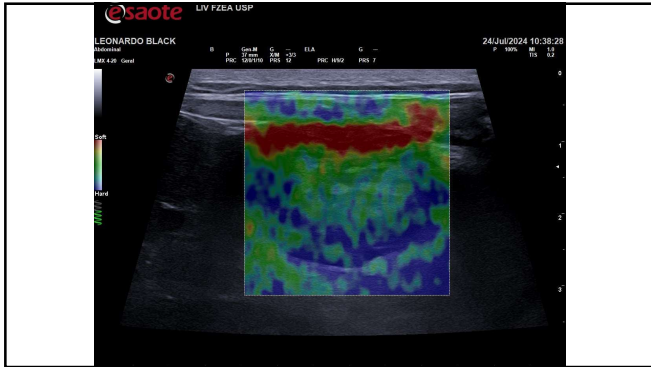
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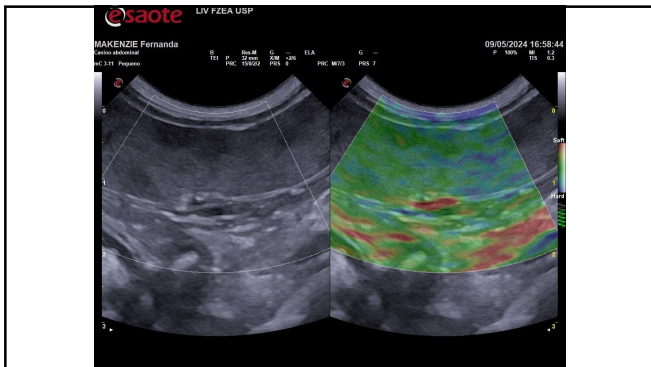
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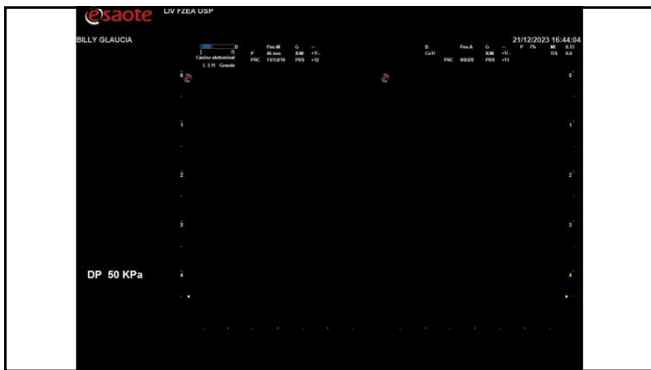
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183



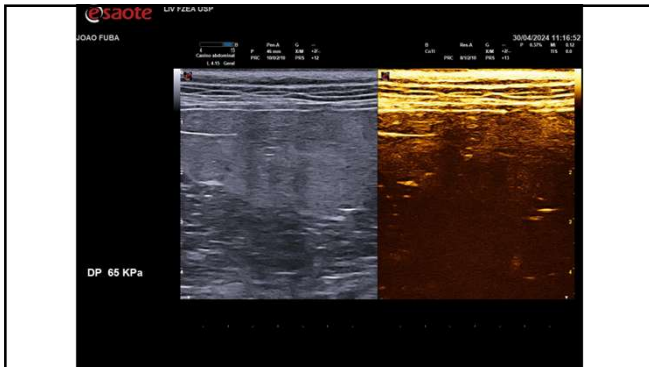
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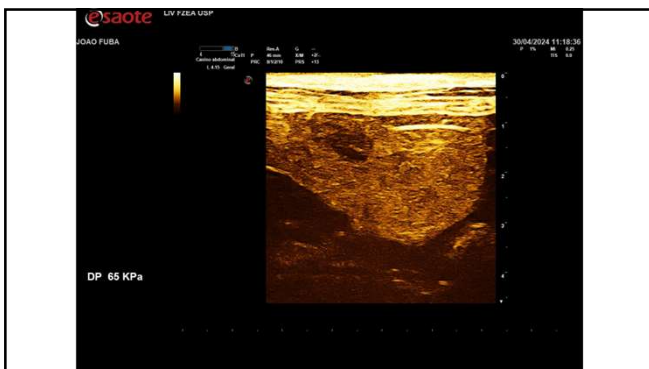
185



186



187



188

FÍGADO

Contrast-Enhanced Ultrasonography for Characterization of Liver Nodules

Christa P. Oliveira, DVM, MS
Nathalie Rademacher, DVM/MS
Lorrie Gaschen, DVM, PhD, Diplomate ECVIM

Detection and characterization of liver tumors represents a diagnostic imaging challenge in both human and veterinary medicine.

Limitations
This study's limitations were:

- The clinical diagnosis was based on cytology in most cases. The use of cytology may be problematic if more than 1 condition is present in the liver or an individual nodule. For example, the cytologic diagnosis of necrosis does not exclude the possibility that malignant neoplasia is also present.
- The number of dogs with each specific tumor type was small.

Future studies that include a larger number of dogs with primary tumors and metastasis from tumors other than hepatocellular carcinoma are needed to (1) better assess the pattern of enhancement of specific tumor types and (2) assess whether primary lesions can be differentiated from metastatic lesions based on CEUS.

189

Table 2. Liver parameters in 3 phases by various researchers.

Author	Hepatic arterial phase (HA)		Portal vein phase (PV)		Hepatic Parenchymal phase (HP)		UCAs
	Phase start (time post injection)	Duration	Phase start (time post injection)	Duration	Phase start (time post injection)	Duration	
1	7-10 s	10-15 s	30-45 s	2 min		4-20 min	
2	10-15 s		30-60 s	150-200 s			Sonovue®
3	15-25 s		80-90 s (45-60s early PV phase)	180-240 s			Sonovue®
4	10 s		30s (peak)		45 s (peak)	15 min	Sonazoid®
5		do 20 s	20 s	40 s	8 min	7 min	Sonazoid®
6	5.47±1.52 s 13.5±3.37 s (peak)		16.03±3.39 s 27.5±4.09 s (peak)				Levovist®

190

CONTRAST-ENHANCED ULTRASONOGRAPHY FOR CHARACTERIZATION OF CANINE FOCAL LIVER LESIONS

KENSUKE NAKAMURA, SATOSHI TAKAGI, NOBORU SASAKI, WICKRAMASEKARA RAJAPAKSHAGE BANDULA KUMARA, MASAHIRO MURAKAMI, HIROSHI OHTA, MASAHIRO YAMASAKI, MITSUYOSHI TAKIGUCHI

In six normal beagles and 27 dogs with spontaneous focal or multifocal liver lesions, contrast-enhanced ultrasonography using Sonazoid® was performed. Sonazoid® is a newly developed second-generation contrast agent with the ability to be used for real-time contrast imaging along with parenchymal imaging. An appropriate protocol for the evaluation of all three phases (arterial, portal, and parenchymal) was established based on the results for normal beagles. By evaluation of the echogenicity of hepatic nodules during the arterial and parenchymal phases it was possible to differentiate malignant tumors from benign nodules with very high accuracy. In 15 of 16 dogs diagnosed as malignant tumors, nodules were clearly hypoechoic to the surrounding normal liver during the parenchymal phase. Additionally, malignant tumors had different echogenicity compared with the surrounding normal liver during the arterial phase in 14 of 15 dogs. In the portal phase, there were no characteristic findings. Contrast-enhanced ultrasonography with Sonazoid® appears to improve the characterization of canine focal and multifocal hepatic lesions. *Veterinary Radiology & Ultrasound*, Vol. 51, No. 1, 2010, pp 79-85.

191

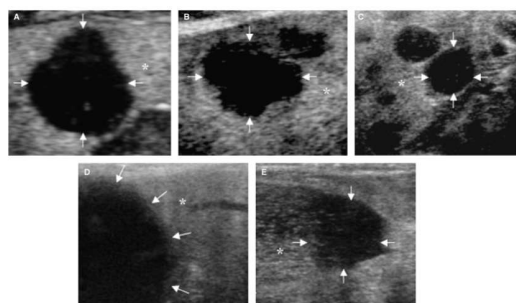
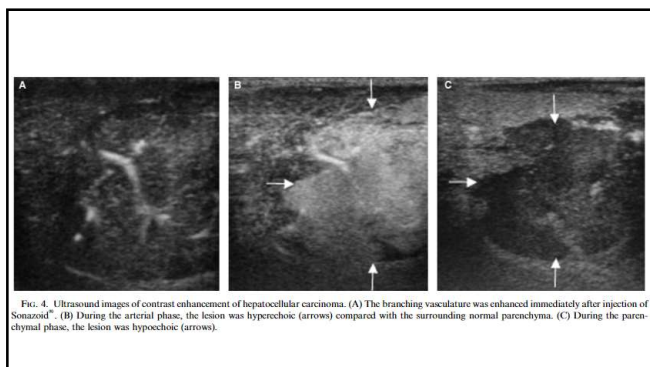
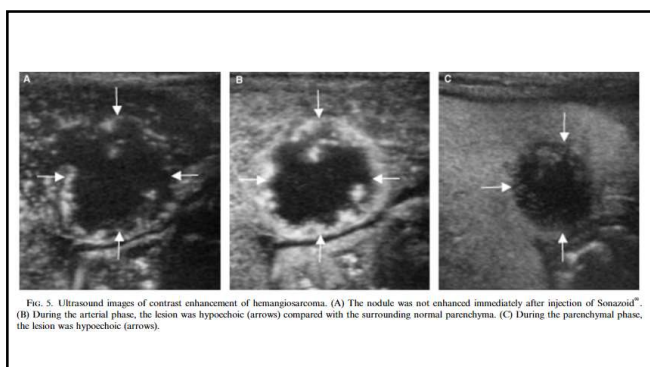


FIG. 2. Ultrasound images of contrast enhancement during the parenchymal phase of hepatic malignant tumors: (A) hepatocellular carcinoma, (B) combined hepatocellular cholangiocellular carcinoma, (C) carcinoma, (D) hepatic oncocoma, (E) lymphoma. All lesions had clear contrast defects (arrow) compared with surrounding normal parenchyma (*).

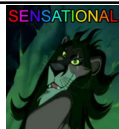
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193



194



The 15 malignancies were comprised of 11 hepatocellular carcinomas, one combined hepatocellular and cholangiocellular carcinoma, one carcinoid, one hemangiosarcoma, and one osteosarcoma. Needle aspirates were taken with ultrasound guidance in the other eight lesions with six suspected hemangiosarcomas, one lymphoma, and one nodular hyperplasia. Finally, 16 lesions were diagnosed as malignant tumors, and six lesions were diagnosed as benign lesions (Table 1).

All six benign lesions were isoechoic to the surrounding normal liver during the parenchymal phase. On the other hand, 15 of the 16 lesions with a confirmed diagnosis of malignancy were hypoechoic (Fig. 2). This finding was significantly ($P<0.01$) correlated with malignancy with an

accuracy of 95.5% (95% confidence interval [CI], 79.5–95.5%), a sensitivity of 93.8% (95% CI, 82.8–93.8%), a specificity of 100% (95% CI, 70.7–100%), a positive predictive value of 100% (95% CI, 88.3–100%), and a negative predictive value of 85.7% (95% CI, 60.6–85.7%). Additionally, five of the six benign lesions were isoechoic during the arterial phase. Among the 15 malignant lesions, conversely, only one lesion was isoechoic, 11 lesions were hyperechoic, and three lesions were hypoechoic. Hyper-echogenicity or hypoechogenicity at the arterial phase was also significantly related to malignancy ($P<0.01$) with an accuracy of 90.5% (95% CI, 72.7–97.3%), a sensitivity of 93.3% (95% CI, 80.9–98.1%), a specificity of 83.3% (95% CI, 52.2–95.3%), a positive predictive value of 93.3% (95%

195

196

CUIDADO!!!

There were some limitations in this study. First, the number of patients with benign nodules was small. Therefore, there were large confidence intervals for the specificity and negative predictive value for differentiation between malignant and benign liver lesions. Second, only one hemangiosarcoma was diagnosed histologically. Third, the criteria for diagnosis were not applied prospectively. A prospective study is needed to confirm the accuracy for differential diagnosis of hepatic nodules.

All 11 mosquitoes were sampled of 11 hepatocellular carcinomas, six combined hepatocellular and cholangiocarcinomas, and five hepatocellular carcinomas without intrahepatic cholangiocarcinoma and no intrahepatic cholangiocarcinoma. Needle aspirates were taken with alcohol-preserved slides in the right epiplon with its surrounding connective tissue, and the aspirates were stained with hematoxylin and eosin (H&E) and examined by light microscopy. Finally, 11 lesions were diagnosed as hepatocellular lesions, and 10 lesions were diagnosed as benign hepatocellular lesions.

All six benign lesions were localized in the surrounding normal liver during the post-mortem phase. On the other hand, the remaining five lesions were localized in the center of malignancy were hepatocellular (Fig. 1). This finding was significantly ($P < 0.01$) correlated with malignancy with a

CHARACTERIZATION OF CANINE FOCAL LIVER LESIONS WITH CONTRAST-ENHANCED ULTRASOUND USING A NOVEL CONTRAST AGENT—SONAZOID

HIDEYUKI KANEMOTO, KOICHI OHNO, KO NAKASHIMA, MASASHI TAKAHASHI, YASUHIITO FUJINO, RYOHEI NISHIMURA,
HAJIME TSUJIMOTO

Contrast-enhanced ultrasound using Sonoazide, a novel contrast medium with a liver-specific Kupffer phase, was evaluated in canine focal liver lesions. Twenty-five dogs with a liver mass were given intravenous Sonoazide, and the enhancement pattern in the arterial, portal, and parenchymal phase was characterized. An enhancement pattern with a hypoenhancing arterial phase and a hyperenhancing portal phase was observed in 10 benign lesions had a filling defect. The diagnostic value of the presence of a filling defect for malignancy was statistically significant (100% sensitivity, 88% specificity, 94.1% positive predictive value, 100% negative predictive value), and was equal to that of hypoenhancement in the portal or delayed phase. The defect pattern was observed in 15 malignant lesions, including 10 hepatocellular carcinomas, 3 hepatocellular adenomas, and two other types of malignancies. In the arterial phase, five of the six hepatocellular carcinomas had hypervascularity, whereas no other lesion was characterized by hypervascularity. In some dogs, additional lesions that could not be observed with conventional B-mode ultrasonography were detected in the parenchymal phase. The results of this study suggest that contrast-enhanced ultrasound with Sonoazide is useful for the diagnosis of canine focal liver lesions. *Veterinary Radiology and Ultrasound*, Vol. 50, No. 2, 2009, pp 188-194.

197

Results

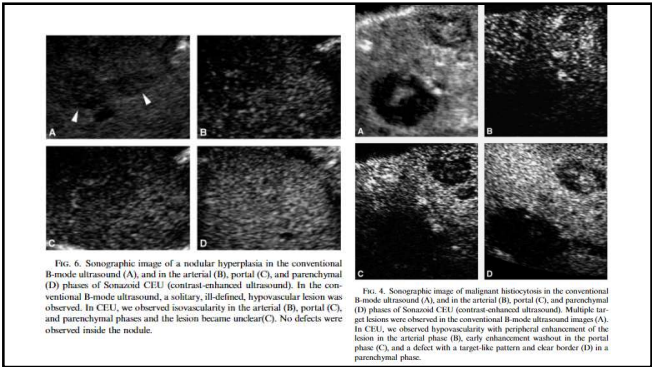
There were nine benign and 16 malignant lesions. All nine benign lesions were hyperplastic nodules, including hepatic nodular hyperplasia ($n = 6$) and cirrhotic nodules ($n = 3$). The 16 malignant lesions included hepatocellular carcinoma ($n = 6$), cholangiocellular carcinoma ($n = 3$), lymphoma, malignant histiocytosis ($n = 1$), mast cell tumor ($n = 1$), leiomyosarcoma ($n = 1$), liposarcoma ($n = 1$), and a sarcoma of unknown origin ($n = 1$). No additional clinical signs or acute allergic reactions including skin or respiratory symptoms were noted.

The pattern of defects in the parenchymal phase was significantly ($P<0.01$) specific for the pathological diagnosis (i.e., irregular defects in hepatocellular carcinoma, clear defects in other malignancies, and no defects in benign nodules). Moreover, the hypoenhancement in the

portal phases was significantly specific for malignancy ($P<0.05$). The sensitivity, specificity, positive predictive value, and negative predictive value of the defect pattern in the parenchymal phase for discriminating histologic or cytologic malignancies from benign nodules were 100%, 88.9%, 94.1%, and 100% for all dogs, respectively. These diagnostic values were 100%, 87.5%, 93.8%, and 100% for dogs which were evaluated in all three phases. These were superior to those of hypoechoogenicity in the portal phase for differentiating malignant lesions from benign ones – 88.9%, 88.9%, and 66.7%, respectively. In the study, although there was no statistically significant difference in the arterial phase, hypervascularity was significantly ($P<0.01$) specific for hepatocellular carcinoma compared with the other types of lesions.

Limitations: Number of dogs with each histologic tumor type was small, and there is the possibility that the images were not representative of each type of tumor. Second, some important types of tumors, such as hepatoma, hemangiosarcoma, or neuroendocrine tumors were not included. Third, the use of anesthesia and patient has an effect on the time-course enhancement of SonoVue; this information is not known for Sonazoid.

198



199

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Contrast-enhanced ultrasound features of malignant focal liver masses in dogs

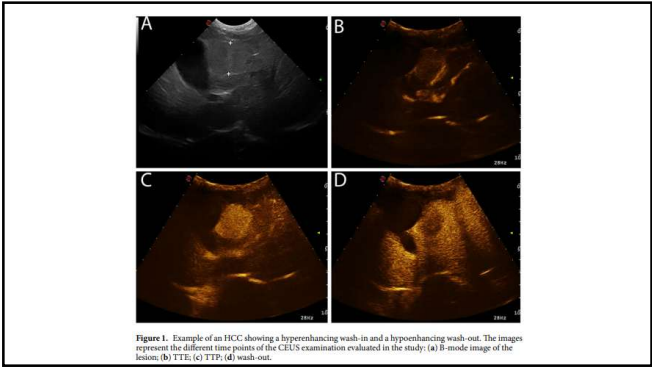
Silvia Burti¹, Alessandro Zotti², Giuseppe Rubini³, Riccardo Orlandi³, Paolo Bargellini³, Federico Bonsembiante^{1*} & Tommaso Banzato^{3*}

A total of 185 cases (150 retrospectively and 35 prospectively) of malignant liver masses were collected. In the retrospectively collected cases hyperenhancement during wash-in was the most common feature in HCCs but there was a high percentage of cases showing no enhancement or hypo/hypo-enhancement. ICCs displayed a large variety of contrast enhancement patterns and, although statically significant differences between ICCs and HCCs were evident, no clear distinction between these two pathologies was possible based only on their CEUS appearance. Sarcomas displayed all the possible degrees of wash-in enhancement with non-enhancing being the most common appearance. Metastases displayed all the possible contrast enhancement patterns, with the most common being hyperenhancement in the wash-in phase followed by hypoenhancement in the wash-out phase. A decision tree was developed based on the features of the retrospectively selected cases. Based on the developed decision tree 27/35 prospectively collected cases were correctly classified. Even if some significant differences among groups were evident, all the histotypes displayed all the possible patterns of contrast enhancement, and, therefore, the differentiation of liver masses in dogs based only on their CEUS features is not feasible and, therefore, cytology or histopathology is required.

Conclusions

According to the results of the present study some differences among the CEUS features of the different histotypes were evident. Nonetheless, as all the histotypes displayed all the possible patterns of contrast enhancement, a differentiation of liver masses in dogs based only on their CEUS features is not feasible and, therefore, cytology or histopathology is required.

200



201

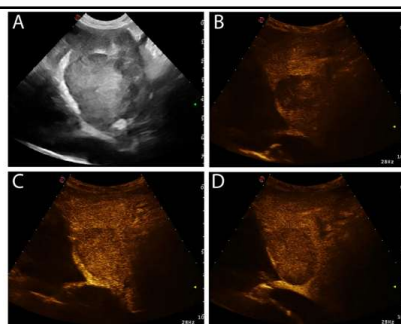


Figure 2. Example of a ICC showing hypoenhancing wash-in and hypoenhancing wash-out and, therefore, this lesion was classified as having "no wash out". The images represent the different time points of the CEUS examination evaluated in the study: (a) B-mode image of the lesion; (b) TTE; (c) TTP; (d) wash-out.

202

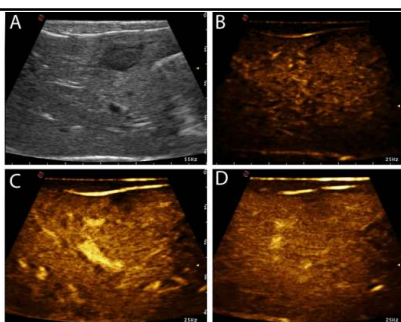


Figure 3. Example of ICC characterised by isoenhancing wash-in and isoenhancing wash-out and, therefore, this lesion was classified as having "no wash out". The images represent the different time points of the CEUS examination that were evaluated in the study: (a) B-mode image of the lesion; (b) TTE; (c) TTP; (d) wash-out.

203

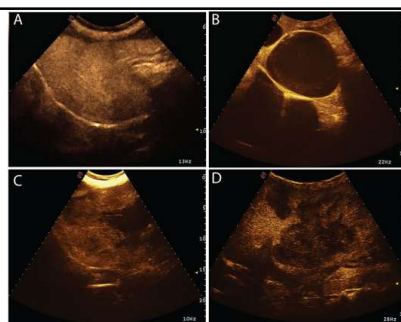
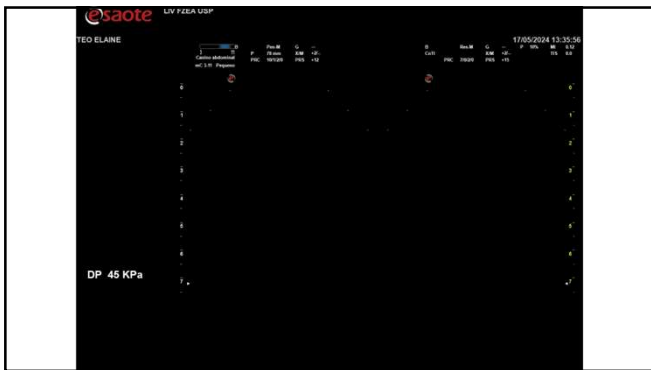


Figure 5. Example of the different margin characteristics that were evaluated for each lesion during the entire CEUS examination: (a) HCC showing unclear and regular margins; (b) sarcoma showing clear and regular margins; (c) ICC showing unclear and irregular margins; (d) metastasis showing clear and irregular margins.

204



205



206



207



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Journal of Veterinary Internal Medicine

STANDARD ARTICLE

Evaluation of duodenal perfusion by contrast-enhanced ultrasonography in dogs with chronic inflammatory enteropathy and intestinal lymphoma

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Background: Contrast-enhanced ultrasonography (CEUS) can be used to evaluate intestinal perfusion in healthy dogs. It is helpful for diagnosing and monitoring inflammatory bowel disease in humans and could be useful for dogs with chronic intestinal diseases.

Objectives: To examine duodenal perfusion in dogs with chronic inflammatory enteropathy (CIE) and intestinal lymphoma.

Animals: Client-owned dogs with CIE (n = 24) or intestinal lymphoma (n = 7) and dogs with gastrointestinal signs but histopathologically normal duodenum (controls, n = 14).

Methods: In this cross-sectional study, dogs with CIE were classified into remission (n = 16) and symptomatic (n = 10) groups based on clinical scores determined at the time of CEUS. The duodenum was scanned after IV injection of Sonoazot[®] (0.01 mL/kg). CEUS-derived perfusion parameters, including time-to-peak, peak intensity (PI), area under the curve (AUC), and wash-in and wash-out rates were evaluated.

Results: The PI was significantly higher in the symptomatic CIE group (median [range]: 105.4 [89.3–128.8] MPV) than in the control group (89.9 [68.5–112.2] MPV). The AUC was significantly higher in the symptomatic CIE group (4847.9 [3824.3–8462.8] MPV.sec) than in the control (3448.9 [1559.5–4736.9] MPV.sec) and remission CIE (3862.3 [2094.5–6899.0] MPV.sec) groups. The PI and clinical score were positively correlated in the CIE group. No significant differences in perfusion parameters were detected between the lymphoma and CIE groups or the lymphoma and control groups.

Conclusions and Clinical Importance: The PI and AUC can detect duodenal inflammation and hence are potentially useful for excluding a diagnosis of CIE.

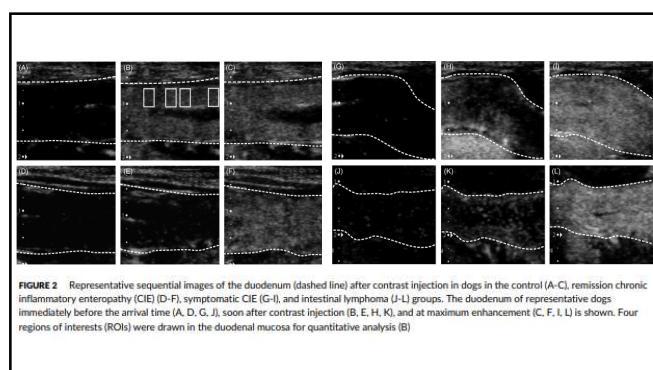
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TABLE 3 Perfusion parameters of control, chronic inflammatory enteropathy, and intestinal lymphoma groups

Variable	Control (n = 14)	Chronic inflammatory enteropathy		Intestinal lymphoma (n = 7)	Overall P value ^a
		Remission (n = 16)	Symptomatic (n = 10)		
TTP [sec] ^b	4.0 (3.0–8.0)	4.0 (2.0–7.0)	6.0 (3.0–7.0)	6.0 (3.0–8.0)	.10 [K]
PI (MPV) ^{c,d}	89.9 (68.5–112.2) ^a	90.9 (61.8–125.9) ^{ab}	105.4 (89.3–128.8) ^b	100.5 (76.7–132.4) ^{ab}	.04 [A]
AUC (MPV.sec) ^{c,d}	3448.9 (1559.5–4736.9) ^a	3862.3 (2094.5–6899.0) ^a	4847.9 (3824.3–8462.8) ^b	4343.7 (2526.8–6237.0) ^{ab}	.01 [B]
WIR (MPV/sec) ^c	23.0 (10.8–31.4)	24.0 (9.3–35.5)	17.8 (13.8–47.7)	17.9 (11.7–29.4)	.23 [K]
WoR (MPV/sec) ^c	(–)0.7 (0.5–0.9)	(–)0.7 (0.5–0.8)	(–)0.7 (0.5–1.1)	(–)0.7 (0.6–1.0)	.53 [K]

Abbreviations: AUC, area under the curve; MPV, mean pixel value; PI, peak intensity; TTP, time to peak; WIR, wash-in rate; WoR, wash-out rate.
^aBased on 1-way analysis of variance (A) or Wilcoxon/Kruskal-Wallis (K).
^bValues are presented as median (range).
^cValues with different superscript letters indicate significant differences among groups based on post hoc analysis (Tukey-Kramer or Steel-Dwais).

212



213

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Citation: Nienhuijs, D., van der Pijl, H., van Erp, A., Siegelman, F., Ruiters, G.J., Brouwer, K., Teunissen, E., Talsma, H., de Waele, E., de Waele, F., et al. (2021) B-mode and Contrast Enhanced Ultrasound: Properties of Gastrointestinal Lymphoproliferative and Neoplastic Diseases. *Frontiers in Oncology* 11:704711. doi: 10.3389/fonc.2021.704711

Keywords: lymphoma, gastric cancer, gastroesophageal junction cancer, esophageal cancer, gastric lymphoma, gastric lymphoproliferative diseases, contrast enhanced ultrasound

Section: Gastric Cancer, Frontiers in Oncology
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Abstract: Carcinogenic gastric disorders are common in veterinary clinical practice and among these neoplasms require rapid identification and characterization. Standard ultrasound (US) is the imaging modality of choice for gastric wall assessment. The aim of this prospective study was to describe the specific B-mode and contrast enhanced ultrasound features of normal, inflammatory, and neoplastic gastric disorders in dogs. Standard and contrast enhanced ultrasound of the stomach were performed in anesthetized dogs with or without gastric disease. Gastroscopically and/or quantitatively parameters were evaluated. A total of 41 dogs were included: 6 healthy as the control group, 9 gastritis (9 gastritis), 8 adenocarcinoma (8 adenocarcinoma), 4 leiomyosarcoma (4 leiomyosarcoma), 2 gastrointestinal lymphoma (2 gastrointestinal lymphoma), 2 leiomyosarcoma (2 leiomyosarcoma), 1 unidentified carcinoma (1 unidentified carcinoma), and 1 unidentified carcinoma (1 unidentified carcinoma). Gastric tumors appear as a marked thickening with absent layer definition and possible regional lymphadenopathy and/or enlarged vessels. Gastric lymphoproliferative diseases and gastric lymphoma generally show no mild thickening and no other abnormalities. Gastric lymphoproliferative diseases show a higher and faster wall in comparison to that of gastritis. B-mode and contrast enhanced ultrasound assessment may be useful in the evaluation of canine gastric disorders in the distinction between benign gastric and gastric neoplasms, even if there are no specific features able to discriminate between different tumor types.

Abstract: Carcinogenic gastric disorders are common in veterinary clinical practice and among these neoplasms require rapid identification and characterization. Standard ultrasound (US) is the imaging modality of choice for gastric wall assessment. The aim of this prospective study was to describe the specific B-mode and contrast enhanced US (CEUS) features of normal, inflammatory, and neoplastic gastric wall in dogs. B-mode US and CEUS of the stomach were performed in anesthetized dogs with or without gastric disease. Gastroscopically and/or quantitatively parameters were evaluated. B-mode US and CEUS examination. A total of 41 dogs were included: 6 healthy (6 healthy) as the control group, 9 gastritis (9 gastritis), 8 adenocarcinoma (8 adenocarcinoma), 4 leiomyosarcoma (4 leiomyosarcoma), 2 gastrointestinal lymphoma (2 gastrointestinal lymphoma), 2 leiomyosarcoma (2 leiomyosarcoma), 1 unidentified carcinoma (1 unidentified carcinoma), and 1 unidentified carcinoma (1 unidentified carcinoma). Gastric tumors appear as a marked wall thickening with absent layer definition and possible regional lymphadenopathy (AL) and/or stenosis and/or vessels gastric generally show no mild thickening and no other abnormalities. Gastric lymphoproliferative diseases show a higher and faster wall in comparison to that of gastritis. B-mode and CEUS assessment may be useful in the evaluation of canine gastric disorders in the distinction between benign gastric and gastric neoplasms, even if there are no specific features able to discriminate between the different tumor histotypes.

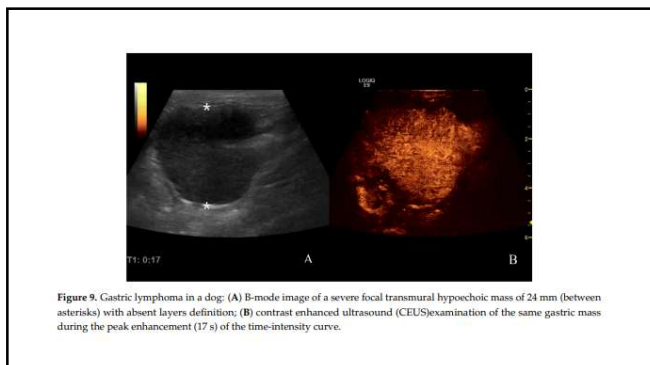
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CEUS Quantitative Features	HEA (n = 21)	INF (n = 13)	CA (n = 8)	AL (n = 8)	LEIS (n = 8)	P-Value*
TA (s)	21.6	13.5	13.8	13.8	9.93	0.007
RT (s)	6.43	7.24	4.84	5.71	7.02	0.414
TP (s)	26.08	26.08	30.3	16.5	30.0	0.040
TF (s)	47.2	54.6	35.3	30.07	42.2	0.010
PE (dB)	36.8	29.3	36.4	34.2	38.6	0.030
WIR (dB/s)	4.4	1.6	1.6	33.2	2.2	0.038

Table 4. Qualitative parameters reported as mean values of CEUS examination for healthy (HEA), inflammatory (INF), adenocarcinoma (AC), lymphoma (AL), and leiomyosarcoma (LEIS).

CEUS Qualitative Variables	HEA (n = 6)	INF (n = 9)	AC (n = 8)	AL (n = 8)	LEIS (n = 4)	p-Value
Enhancement degree						0.93
Hypo/isoenhancing	66.7	88.9	100	75	50	
Hyperenhancing	33.3	11.1	0	25	25	
Non-enhancing	0	0	0	25	25	
Enhancement homogeneity						<0.001
Homogeneous	100	100	12.5	50	25	
Heterogeneous	0	0	87.5	50	50	
No uptake	0	0	0	25	25	
Comb teeth-like vessels						0.73
Present	0	0	12.5	0	0	
Absent	100	100	87.5	100	100	

215



216

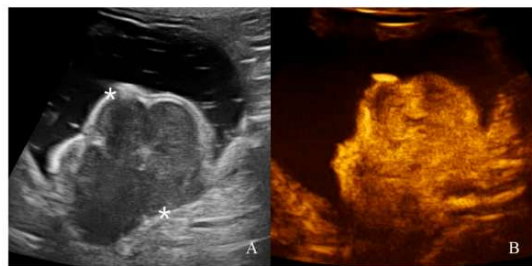


Figure 10. Gastric leiomyosarcoma in a dog: (A) B-mode image of a focal hyperechoic wall mass protruding into the gastric lumen (19.3 mm between asterisks) with no layers definition; (B) CEUS examination of the same dog during the peak enhancement of the time-intensity curve.

217



218

Use of Contrast-Enhanced Ultrasound in the Differential Diagnosis of Adrenal Tumors in Dogs

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ABSTRACT

We evaluated the diagnostic accuracy of the contrast-enhanced ultrasonography (CEUS), using a second-generation microbubble contrast agent, in differentiating the different types of adrenal mass lesions in 24 dogs. At B-mode ultrasound, 9 lesions involved the right adrenal gland, 14 the left, and 1 was bilateral. Each dog received a bolus of the contrast agent into the cephalic vein, immediately followed by a 5-mL saline flush. The first contrast enhancement of each adrenal lesion was evaluated qualitatively to assess the degree of enhancement and its distribution during the wash-in and wash-out phases, as well as the presence of non-vascularized areas and specific vascular patterns.

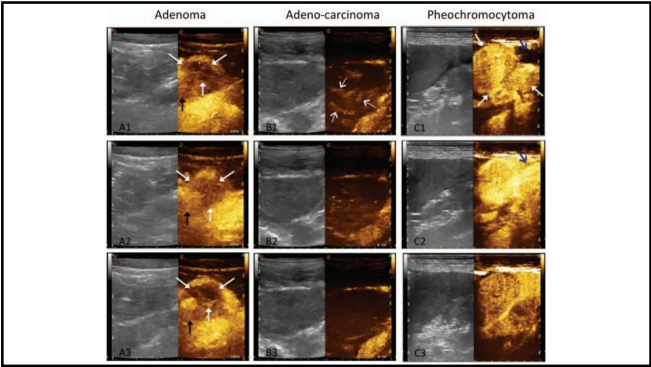
Pathological diagnoses were determined in all dogs by histopathology or by cytology. Combining enhancement degree and vascularity resulted in the best predictive model, allowing CEUS to differentiate adrenocortical adenoma (n=10), adrenocarcinoma (n=7), and pheochromocytoma (n=7) with an accuracy of 91.7% ($P < 0.001$). Combining enhancement degree and vascularity, CEUS can discriminate malignant versus benign adrenal lesions with a sensitivity of 100.0%, a specificity of 80.0%, and an accuracy of 91.7% ($P < 0.001$). In conclusion, results of this study confirm that CEUS is useful for differentiating between the different types of adrenal tumors in dogs. *J Am Anim Hosp Assoc* 2016;52:132-143. DOI 10.5326/JAHA-MS-6363

219

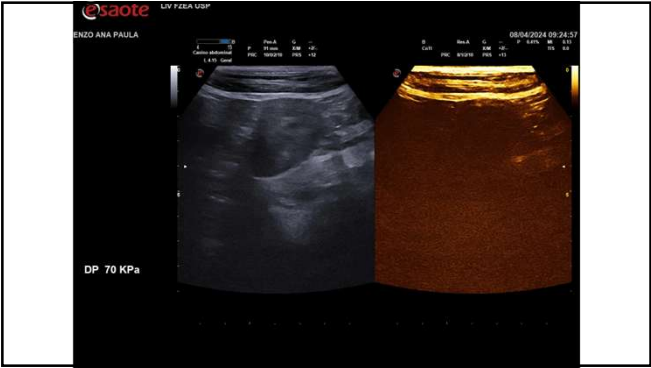
Enhancement Patterns in 24 Adrenal Lesions Grouped According to the Reference Diagnosis Examined in 23 Dogs on Contrast-Enhanced Ultrasonography*				
CEUS Qualitative Variable	Adenoma (n=10)	Adenocarcinoma (n=7)	Pheochromocytoma (n=7)	P
Enhancement degree				
Hypo-enhancement	10 (100.0) [‡]	7 (100.0) [‡]	0 (0.0) [‡]	0.001
No-enhancement	0 (0.0) [‡]	0 (0.0) [‡]	0 (0.0) [‡]	
Hyper-enhancement	0 (0.0) [‡]	0 (0.0) [‡]	7 (100.0) [‡]	
Enhancement distribution				0.05
Homogeneous	6 (60.0) [‡]	0 (0.0) [‡]	3 (42.9) [‡]	
Heterogeneous	2 (20.0) [‡]	4 (57.1) [‡]	4 (57.1) [‡]	
Nodular	2 (20.0) [‡]	3 (42.9) [‡]	0 (0.0) [‡]	
Vascularity				0.01
Presence	8 (80.0) [‡]	0 (0.0) [‡]	3 (42.9) [‡]	
Absence	2 (20.0) [‡]	7 (100.0) [‡]	4 (57.1) [‡]	
Enhancement pattern				0.01
Central	7 (70.0) [‡]	1 (14.3) [‡]	0 (0.0) [‡]	
Peripheral	1 (10.0) [‡]	2 (28.6) [‡]	0 (0.0) [‡]	
Disordered	2 (20.0) [‡]	4 (57.1) [‡]	7 (100.0) [‡]	
Wash-in				0.001
Slow	10 (100.0) [‡]	7 (100.0) [‡]	0 (0.0) [‡]	
Synchronous	0 (0.0) [‡]	0 (0.0) [‡]	6 (85.7) [‡]	
Fast	0 (0.0) [‡]	0 (0.0) [‡]	1 (14.3) [‡]	
Wash-out				0.001
Slow	0 (0.0) [‡]	0 (0.0) [‡]	7 (100.0) [‡]	
Synchronous	0 (0.0) [‡]	0 (0.0) [‡]	0 (0.0) [‡]	
Fast	10 (100.0) [‡]	7 (100.0) [‡]	0 (0.0) [‡]	

*Descriptive analysis and Fisher's exact test: number of adrenal lesions and percentage (in parentheses). The enhancement characteristics of the adrenal lesions were compared to normal surrounding adrenal tissue or contralateral adrenal gland. The single dog with a diagnosis of lipoma was excluded from the statistical analysis. ‡Values in the same row are not significantly different.

220



221



222

Utility of contrast-enhanced ultrasound in differential diagnosis of adrenal tumors in dogs

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ABSTRACT. This prospective case study aimed to clarify the clinical significance of contrast-enhanced ultrasound (CEUS) for the differential diagnosis of canine adrenal tumors. Forty-three client-owned dogs with adrenal tumors were included. All dogs underwent CEUS, which was evaluated qualitatively and quantitatively. The peak signal intensity (PI), time to peak signal intensity (TPI), mean transit time (MTT), upslope, and downslope were calculated for each time-intensity curve. The histopathological diagnosis of each resected mass was compared with the CEUS findings and parameters. Enhancement distribution, vascularity, tortuosity, vascularity, enhancement pattern, and late-phase enhancement did not differ significantly between adrenal cortical adenoma (CA), adrenocarcinoma (CAC), and pheochromocytoma (PHEO) in qualitative assessment. In PHEO, the TPI was significantly more rapid compared with that in CA ($P=0.0287$) and CAC ($P=0.0404$). The MTT in PHEO was significantly shorter than that in CA ($P=0.0016$) and CAC ($P=0.0003$). Upslope in PHEO was larger than that in CAC ($P=0.0406$). Downslope in PHEO was significantly larger than that in CA ($P=0.0048$) and CAC ($P=0.0018$). A receiver operating characteristic curve analysis demonstrated that the area under the MTT curve yielded 0.91 for distinguishing PHEO from adrenocortical tumors in dogs; an MTT cut-off value less than 6.225 msec yielded a sensitivity of 69%, specificity of 94%, and likelihood ratio of 12.46. CEUS appears to be clinically applicable for the differential diagnosis between cortical and medullary origins of primary adrenal tumors in dogs.

KEY WORDS: adrenal tumor, contrast-enhanced ultrasound, dog, sonazoid

223

Table 1. Qualitative assessment of contrast-enhanced ultrasound in canine adrenal tumors

Parameters	CA (n=5)	CAC (n=11)	PHEO (n=26)	P-value
Enhancement distribution				
Homogeneous	2	1	3	0.2120
Heterogeneous	3	10	23	
Vascularity				
Presence	3	10	18	0.2954
Absence	2	1	8	
Tortuosity				
Presence	0	4	10	0.1861
Absence	3	6	8	
Enhancement pattern				
Centripetal	1	4	14	0.4408
Centrifugal	1	2	1	
Disseminated	0	2	8	
Nodular	3	3	3	
Late-phase enhancement				
Presence	3	3	6	0.2449
Absence	2	8	20	

CA, cortical adenoma; CAC, cortical adrenocarcinoma; PHEO, pheochromocytoma.

Table 2. Quantitative parameters of contrast-enhanced ultrasound in canine adrenal tumors

	CA (n=6)	CAC (n=12)	PHEO (n=26)	P-value		
				CA vs. CAC	CA vs. PHEO	CAC vs. PHEO
PI (power)	0.59×10^{-4} [5.77 $\times 10^{-4}$ –1.51 $\times 10^{-3}$]	0.74×10^{-4} [3.49 $\times 10^{-4}$ –4.41 $\times 10^{-3}$]	1.05×10^{-4} [8.12 $\times 10^{-4}$ –2.21 $\times 10^{-3}$]	>0.9999	0.4504	0.1498
TPI (msec)	6.939 [3.647–11.406]	5.962 [2.982–42.683]	4.200 [2.144–8.354]	>0.9999	0.0287	0.0404
MTT (msec)	20.992 [9.581–49.036]	12.303 [6.196–54.606]	5.541 [2.165–23.931]	>0.9999	0.0016	0.0003
Upslope	1.46×10^{-8} [7.23 $\times 10^{-10}$ –5.06 $\times 10^{-7}$]	1.73×10^{-8} [1.48 $\times 10^{-10}$ –7.25 $\times 10^{-7}$]	3.64×10^{-8} [3.23 $\times 10^{-9}$ –6.00 $\times 10^{-7}$]	>0.9999	0.1181	0.0406
Downslope	1.27×10^{-8} [6.42 $\times 10^{-10}$ –8.01 $\times 10^{-7}$]	3.26×10^{-8} [7.31 $\times 10^{-10}$ –9.18 $\times 10^{-7}$]	1.25×10^{-8} [1.01 $\times 10^{-9}$ –2.19 $\times 10^{-7}$]	>0.9999	0.0048	0.0018

Values are presented as median [range]. CA, cortical adenoma; CAC, cortical adrenocarcinoma; PHEO, pheochromocytoma.

224

SISTEMA REPRODUTOR MASCULINO

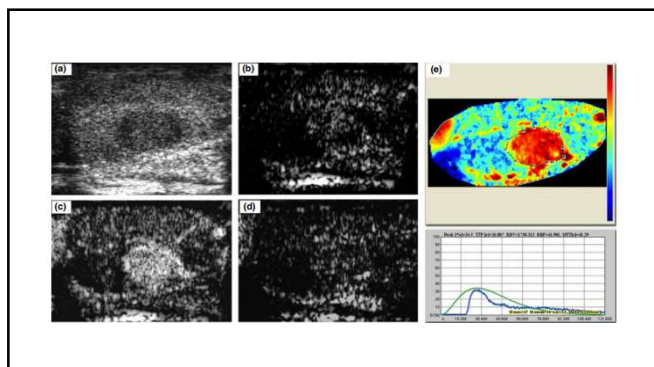
B -mode and Contrast-Enhanced Ultrasonographic Findings in Canine Prostatic Disorders

M Russo, M Vignoli, GCW England

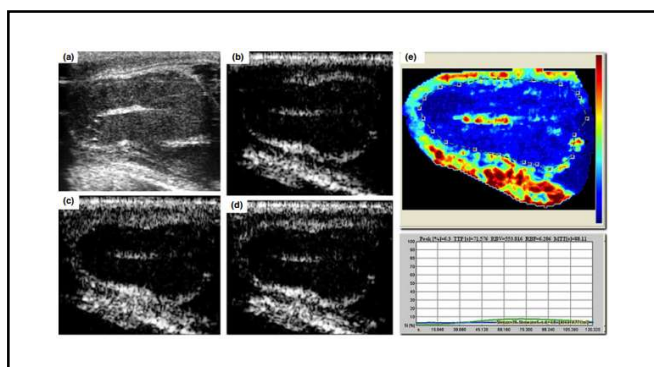


Whilst measurement of prostatic volume and the ultrasonographic appearance did not appear to be particularly useful for differentiating prostatic pathologies, the measurement of vascular perfusion kinetics using contrast-enhanced ultrasound illustrates some exciting possibilities. There was a clear increase in both the percentage peak intensity and time to peak in dogs with malignant prostatic disease compared with dogs with benign disease and normal dogs. Further studies into vascular perfusion kinetics seem warranted.

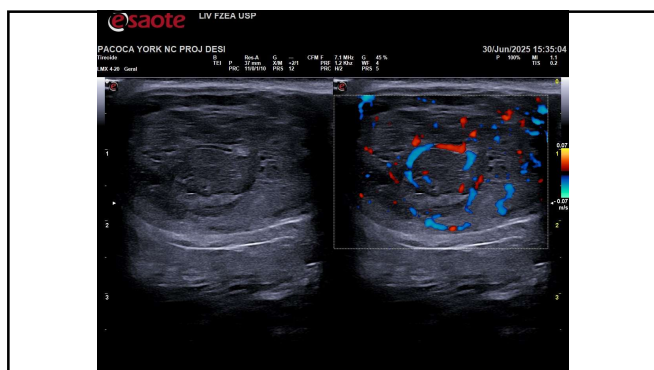
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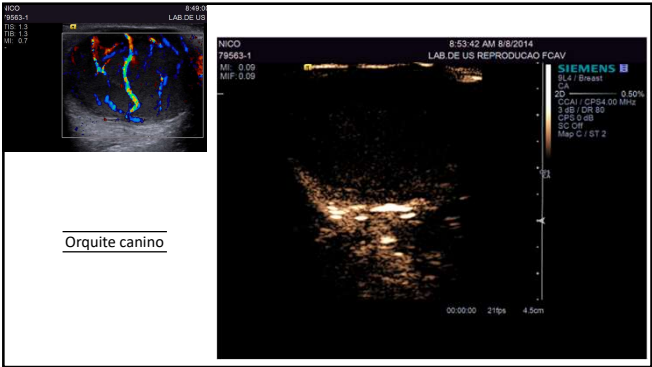
229



230



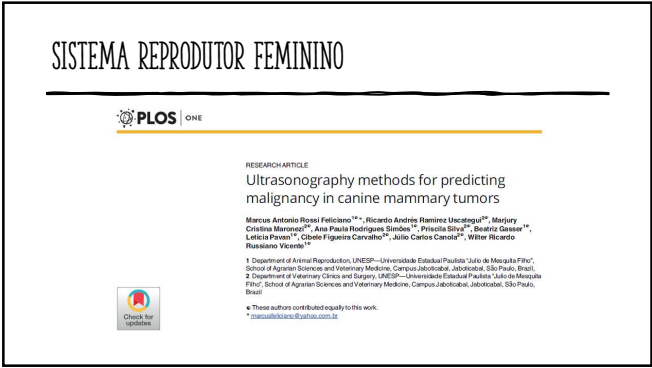
231



232



233



234

Veterinary Radiology & Ultrasound

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Accuracy of four ultrasonography techniques in predicting histopathological classification of canine mammary carcinomas

Marcos Antonio Rossi Feliciano, Ricardo Andrés Uscategui Ramírez, Marjory Cristina Maronezi, Giovanna Serpa Maciel, Michelle Lopes Avante, Igor Luiz Salazar Senhorello ... See all authors

carcinoma, with 80% sensitivity and 76% specificity. Contrast wash-in and peak enhancement times lower than 7.5 and 13.5 s, respectively, were indicative of complex carcinoma at 62% sensitivity and 60% specificity. Contrast wash-in, peak enhancement, and wash-out times greater than 6.5, 12.5, and 64.5 s, respectively; were indicative of grade II and III carcinoma at 68% sensitivity and 62% specificity. In conclusion, B-mode

FELICIANO, M.A.R.

75

235

Carcinoma sólido grau III

236

Carcinoma mamário em tumor misto grau II

237

OUTROS

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Short communication

Contrast-enhanced ultrasound sonography combined with strain elastography to evaluate mandibular lymph nodes in clinically healthy dogs and those with head and neck tumors

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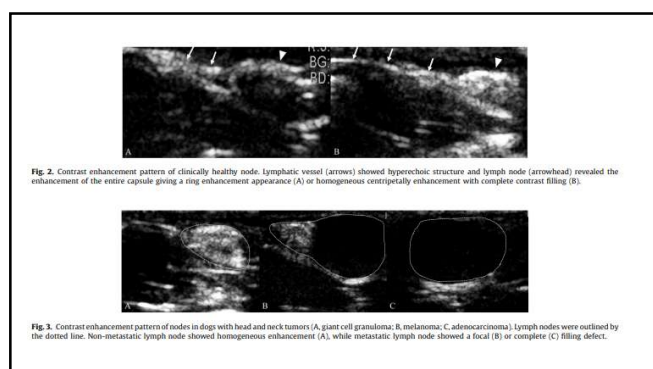
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 Head and neck cancer
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 Perichapsal microbubble
 Strain elastography

ABSTRACT

Determining lymph node metastases in dogs with neoplasia is important in staging and developing a therapeutic plan. In this study, the clinical efficacy of combined lymphosonography and strain elastography was evaluated for its ability to identify metastatic mandibular lymph nodes. Data from clinically healthy dogs ($n = 10$) and those with head/neck tumors ($n = 11$) were reviewed. Strain elastographic patterns were classified according to the percentage of the stiffness lymph node area (grade 1–4%). Lymphosonographic images were evaluated quantitatively (visualization of lymphatic vessels/lymph nodes; contrast transit time) and qualitatively (enhancement pattern). There was a significant difference in the strain elastographic pattern ($P = 0.011$) and lymphosonographic contrast enhancement ($P = 0.002$) in the metastatic nodes compared to clinical healthy or non-metastatic nodes. Mandibular lymph nodes with filling defects after lymphosonography and high-grade strain elastographic patterns suggested metastasis, and the combination of lymphosonography and strain elastography was useful for identifying malignancy.

238



239

Table 2
 Grey scale ultrasonography, strain elastography and lymphosonographic findings in clinically healthy, non-metastatic and metastatic mandibular lymph nodes.

		Clinically healthy ^a	Non-metastatic (n = 5)	Metastatic (n = 6)	P
Grey scale ultrasonography	Short axis diameter (cm) ^b	0.32 (0.22–0.48)	0.59 (0.30–1.09)	0.86 (0.31–1.52)	0.083
	Long axis diameter (cm) ^b	0.90 (0.51–1.25)	1.53 (0.63–3.93)	1.53 (0.7–3.91)	0.835
	Short to long axis ^b	0.42 (0.29–0.53)	0.43 (0.32–0.51)	0.60 (0.33–1.23)	0.316
	Border ^c	11	5	5	0.264
Strain elastography	Smooth	0	0	1	
	Irregular	0	0	0	
	Paranechymal echogenicity ^c	1	0	0	0.607
	Isoechoic	10	5	6	
Lymphosonography	Hypoechoic	1	3	1	0.011 ^d
	Elastographic pattern ^e	1	3	1	
	2	5	2	0	
	3	0	0	2	
Lymph node Enhancement patterns ^f	4	0	0	3	
	Lymphatic vessel	1.2 (0.7–1.8)	1 (1–1.4)	1 (1)	0.718
	Contrast transit time (min) ^g	3 (3–7)	1 (1)	1 (1)	0.12
	Lymph node	5 (1–7)	1 (1)	1 (1)	0.08
Lymph node Enhancement patterns ^f	Normal filling ^h	11	4	0	0.001 ^d
	Filling defect ⁱ	0	1	6	

^a Dogs were enrolled in either of both strain elastography and lymphosonography (grey scale ultrasonography, $n = 16$; strain elastography, $n = 11$; lymphosonography, $n = 11$). Five dogs were <1 year old.

^b Data are expressed as median (range).

^c Data area expressed as number of dogs.

^d Among clinically healthy dogs, four dogs showed capsular filling enhancement.

^e 1, 0; 0, 0.

240

Contrast-enhanced ultrasonography characteristics of intrathoracic mass lesions in 36 dogs and 24 cats

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Abstract

Contrast-enhanced ultrasonography (CEUS) is increasingly available for veterinary patients, however limited studies describe the use of this method for characterizing intrathoracic mass lesions. The aim of this prospective, observational study was to describe CEUS enhancement patterns for intrathoracic mass lesions in a sample of cats and dogs. Sixty patients (36 dogs, 24 cats) were included. Standardized CEUS examinations were performed for 41 pulmonary masses (68%) and 19 mediastinal masses (32%). Final diagnosis was based on cytology and/or histopathology. Absolute time to enhancement (TTE) values were recorded for the intrathoracic mass lesions and spleen. The spleen was used as a reference parenchymal organ to calculate relative TTE (rTTE) values. Absolute TTE of the spleen and intrathoracic mass lesions differed for dogs and cats ($P = 0.001$). The rTTE values significantly differed between lesions of neoplastic versus non-neoplastic origin ($P = 0.004$). The majority of neoplastic pulmonary masses were supplied by bronchial arteries (63%), while most nonneoplastic pulmonary masses were supplied by pulmonary arteries (78%). The sensitivity and specificity for detecting pulmonary neoplastic masses with rTTE were 63% and 78%, respectively. Enhancement patterns for mediastinal thymomas and lymphomas significantly differed ($P < 0.002$). Thymomas enhanced heterogeneously in a centripetal pattern (84%), whereas lymphomas typically enhanced uniformly in a centrifugal pattern (75%). Findings indicated that CEUS is a feasible method for characterizing intrathoracic mass lesions in dogs and cats, however, the diagnostic sensitivity for detecting neoplastic pulmonary masses was low.

241

TABLE 2 Contrast enhanced ultrasonography characteristics of six other intrathoracic masses

	Absolute TTE (s)	Relative TTE	TTP (s)	Wash-in time (s)	Wash-out time (s)	Maximum contrast intensity (dB)	Homogeneity of enhancement
Generalized pulmonary lymphoma	4	early	22	11	98	14	homogeneous
Pulmonary lung lobe torsion	0	0	0	0	0	0	no enhancement
Mediastinal nerve sheath tumor	16	delayed	36	17	25	4	heterogeneous
Mediastinal hemangiosarcoma	8	delayed	20	7	47	12	homogeneous
Mediastinal melanoma	12	delayed	24	7	39	14	heterogeneous
Tracheal lymphoma	3	delayed	13	7	15	15	heterogeneous

Abbreviations: dB, decibel; s, seconds; TTE, time to enhancement; TTP, time to peak.

242

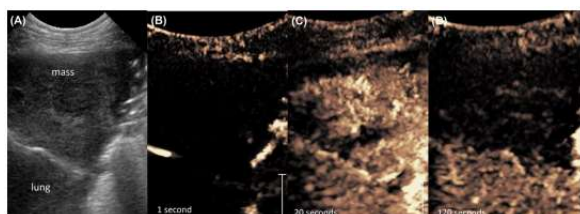
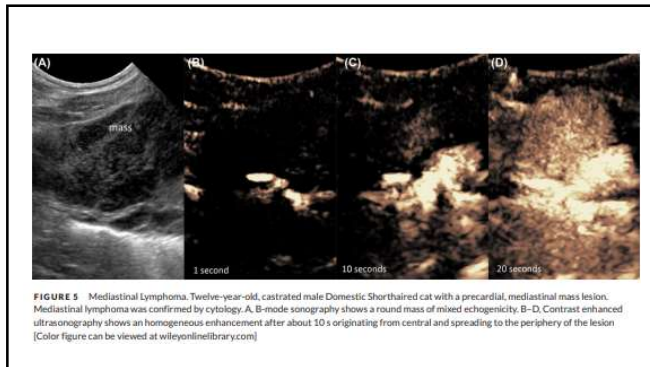
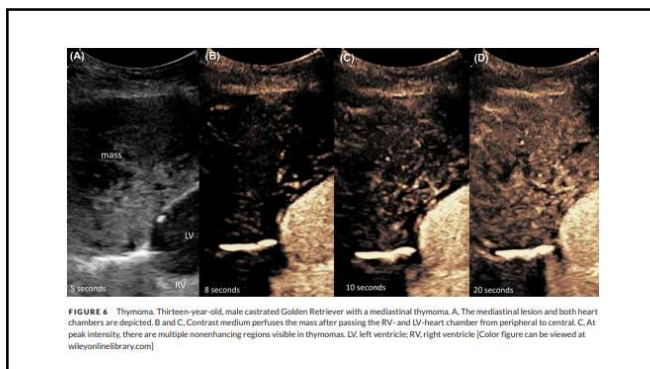


FIGURE 4 Pulmonary adenocarcinoma. Eight-year-old female neutered German Pinscher with an adenocarcinoma in the left caudal lung lobe. A, B-mode sonography shows a triangular, hypochoic, pleural based mass-lesion. B and C, Contrast enhanced ultrasonography shows a delayed enhancement at the same time as the spleen. D, After 120 s no enhancement was visible within the mass [Color figure can be viewed at wileyonlinelibrary.com]

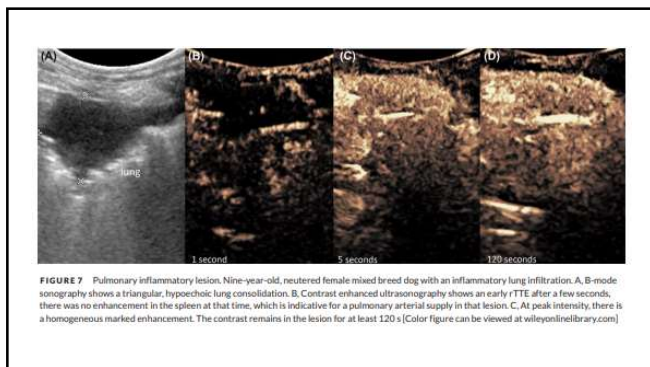
243



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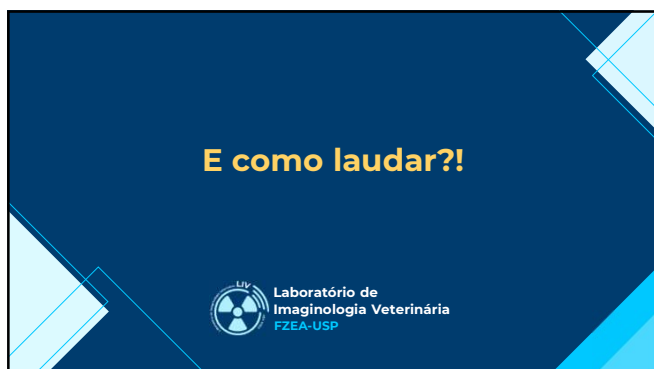
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246



247



248

))) E concluindo... Alguns pontos importantes!

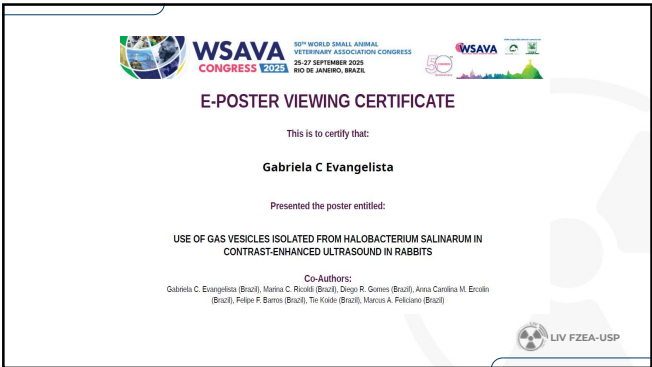
1. As duas principais aplicações hoje, na veterinária do CEUS, é a avaliação da função tecidual e rupturas
2. “Falar” sobre malignidade é irresponsável e precisamos de estudos mais completos e lembrar sempre:
 - padrão-ouro é histopatologia
 - devemos pensar no bem-estar do proprietário e paciente!

LIV FZEA-USP

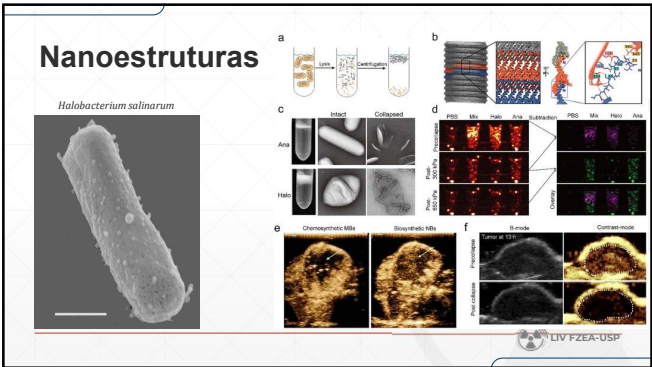
249



250



251



252



253

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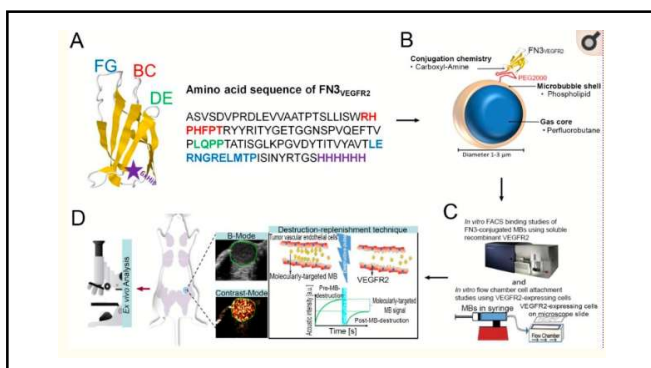
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Published online 2016 Jun 28. doi: [10.7155/thno.15169](https://doi.org/10.7155/thno.15169) PMID: [27570547](https://pubmed.ncbi.nlm.nih.gov/27570547/)

Ultrasound Molecular Imaging of the Breast Cancer Neovasculature using Engineered Fibronectin Scaffold Ligands: A Novel Class of Targeted Contrast Ultrasound Agent

[Lotfi Abou-Elkacem](#)¹ [Katherine E. Wilson](#)¹ [Sadie M. Johnson](#)² [Sayan M. Chowdhury](#)¹ [Sunita Bachawal](#)¹ [Benjamin J. Hackel](#)² [Lu Tian](#)³ and [Jürgen K. Willmann](#)^{1,✉}

Theranostics

254



255

RETURN TO ISSUE | < PREV ARTICLE NEXT >

Ultrasound Molecular Imaging of Angiogenesis Using Vascular Endothelial Growth Factor-Conjugated Microbubbles

Jianjun Wang[†], Bin Qin[†], Xucai Chen[†], William R. Wagner[†], and Flordeliza S. Villanueva^{†*}



Molecular Pharmaceutics

decreased with increasing wall shear rate. On intravital microscopic imaging of bFGF-stimulated rat cremaster muscle, there was greater microvascular adhesion of MB_{VEGF} compared to that of isotype IgG-conjugated control MB (MB_{CTL}). To determine if MB_{VEGF} could be used to ultrasonically image angiogenesis, ultrasound imaging was performed in mice bearing squamous cell carcinoma after intravenous injection of MB_{VEGF}. Ultrasound videointensity enhancement in tumor was significantly higher for MB_{VEGF} (17.3 ± 9.7 dB) compared to MB_{CTL} (3.8 ± 4.4 dB, $n = 6$, $p < 0.05$). This work demonstrates the feasibility of targeted ultrasound imaging of an angiogenic marker using MB_{VEGF}. This approach offers a noninvasive bedside method for detecting tumor angiogenesis and could be extended to other applications such as molecular monitoring of therapeutic angiogenesis or antiangiogenic therapies in

256

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257

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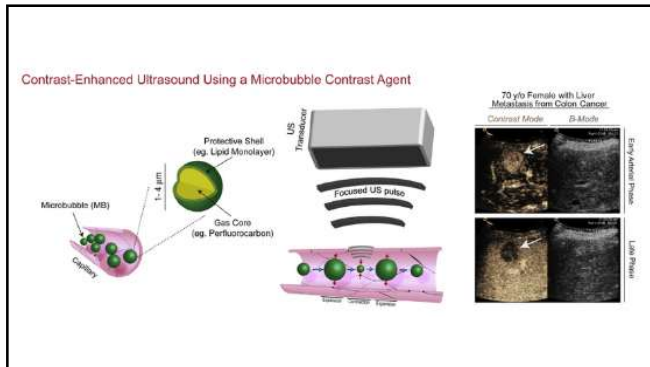
Jianjun Wang[†], Bin Qin[†], Xucai Chen[†], William R. Wagner[†], and Flordeliza S. Villanueva^{†*}



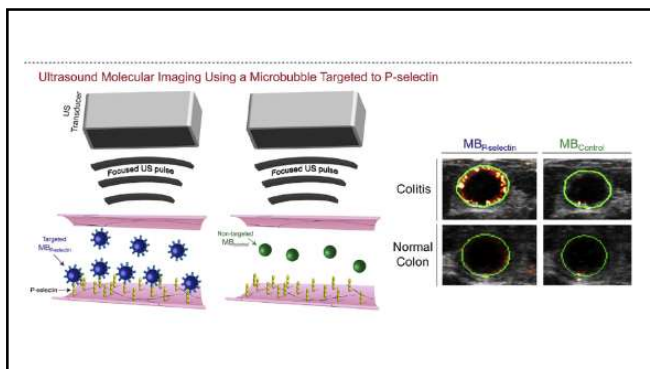
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258



259



260

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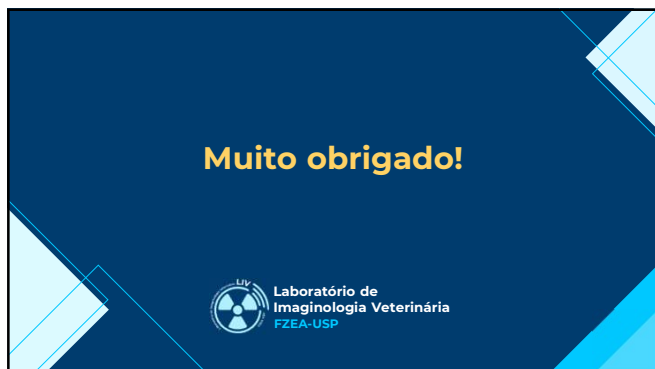
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261



262
