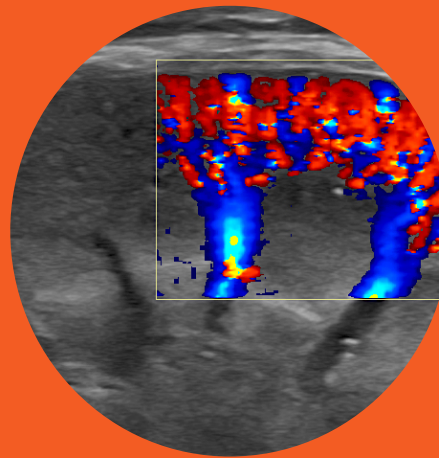


Advanced vascular ultrasound with focus in portal hypertension

Gigliola Spattini
DVM, GP Cardio, CCRT, PhD, DECVDI



Objectives

- Optimize machine and Doppler setting is fundamental to assess vascular and portal circulation
- This presentation focuses on the key hemodynamic and morphological features of portal hypertension



Pepe, Lagotto, MI, 7 years

08/06

- Anorexia and weight loss
- Recurrent episodes of watery diarrhoea
- Vomiting
- Fever



Pepe, MI, 7 years



RBC (milioni / μ L):	5.73	5.70	8.56	Acantociti:		Elipociti:	
HGB (g/dL):	13.6	14.1	21.2	Anisocitosi:		Ipocromia:	
HCT (%):	38.8	39.0	59.2	Agglutinazione:		Macroцитi:	
MCV (fL):	67.8	63.1	72.6	Codociti:		Microцитi:	
MCH (pg):	23.8	21.8	25.4	Cherociti:		Parassiti eritrocitari:	
MCHC (g/dL):	35.1	33.3	36.8	Chizociti:		Policromasia:	
CHCM (g/dL):		34.3	37.8	Corpi di Heinz:		Punteggiatura basofila:	
MCHC/CHCM:		0.94	1.01	Corpi di Howell-Jolly:		Rouleaux:	
CH (pg):		22.0	26.0	Cristalli di Hb:		Schistociti:	
CHDW (pg):		2.72	3.34	Dacriociti:		Selenociti:	
RDW (%):	15.9	11.6	14.7	Dracociti:		Sferociti:	
HDW (g/dL):		1.63	2.22	Eccentricociti:		Stomatociti:	
NRBC/100 WBC:	0	0	0	Echinociti:	+	Torociti:	
Varie RBC:							
WBC (x 1000 / μ L):	32.6	5.45	12.98	Linfociti attivati:			
Conta corr. WBC (x 1000 / μ L):		5.45	12.98	Linfociti atipici:			
Mielociti (/ μ L):	0	0	0	Neutrofili tossici:	-		
Metamielociti (/ μ L):	0	0	0	Corpi di Doehle:			
Neutrofili banda (/ μ L):	326	0	286	Schiumosità citopl.:			
Neutrofili segmentati (/ μ L):	30644	3555	9314	Vacuolizzazione citopl.:			
Linfociti (/ μ L):	652	1169	3810	Basofilia citopl.:			
Monociti (/ μ L):	652	186	798	Granuli tossici:			
Eosinofili (/ μ L):	326	104	1164	Neutrofili giganti:			
Basofili (/ μ L):	0	0	106	Macroplaciti:			
Danneggiate (/ μ L):	0	0	0				
Indifferenziate (/ μ L):	0	0	0				
Altre (/ μ L):	0	0	0				
Varie WBC:							
PLT (1000 / μ L):	238	176	479	Stima PLT:	ADEG: <input checked="" type="checkbox"/>	INADEG: <input type="checkbox"/>	AUMENT: <input type="checkbox"/>
MPV (fL):	6.7	8.9	15.0	Varie:	Piastrine attivate: <input type="checkbox"/>	Macroplacitrine: <input checked="" type="checkbox"/>	
PCT (%):	0.160	0.21	0.52		Piastrine allungate: <input type="checkbox"/>	Inclusi piastrinici: <input type="checkbox"/>	
PDW (%):	10.1	51.8	74.5				

Pepe, MI, 7 years

CPK (IU/L):	1238	42-155
AST (IU/L):	168	20-50
ALT (IU/L):	112	15-50
ALP (IU/L):	353	20-110
GGT (IU/L):	9.6	1-11
Colinesterasi (IU/L):		3347-7074
Bilirubina Totale (mg/dL):	0.17	0.15-0.4
Proteine Totali (g/dL):	5.0	5.5-7.5
Albumine (g/dL):	2.1	2.7-3.6
Globuline (g/dL):	2.9	2.6-3.9
Rapporto A/G:	0.72	0.7-1.2
Colesterolo (mg/dL):	108	150-350
Trigliceridi (mg/dL):	50	30-110
AMILASI (IU/L):	5073	300-1800
Lipasi (dggr) (U/L):	970	29-143
Urea (mg/dL):	39	18-45
Creatinina (mg/dL):	0.50	0.75-1.3
Glucosio (mg/dL):	15	80-100
Calcio (mg/dL):	7.1	8.2-12
Fosforo (mg/dL):	3.6	2.1-6.2
Magnesio (mg/dL):		0.67-0.94
Sodio (mEq/L):	142	143-151
Potassio (mEq/L):	2.3	3.9-5.1
Rapporto Na/K:	61.7	28.5-37.4
Cloro (mEq/L):	108	109-118
Cloro corretto (mEq/L):	111.0	109.1-115.9
HCO-3 (mmol/L):		18.4-24.8
Divario Anionico:		13.1-19.4
Osmol. sier. calc. (mOsm):	274	277-291
Ferro totale (µg/dL):	88	100-200
UIBC (µg/dL):		182-306
TIBC (µg/dL):		318-479
Saturazione (%):		28.2-56.8
Prot. C Reattiva (mg/dL):	1.13	0.01-0.22

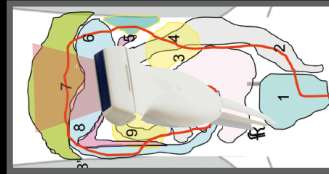


Osmolalità (mosm/Kg):	412	1955
Peso Specifico:	1026	1010 1056
pH:	6.5	5.5 8.5
Glucosio Urinario (mg/dl):	0	0 0
Chetoni (mg/dl):	0	0 0
Bilirubina (mg/dl):	0.5	0.0 0.5
Sangue occulto - Hb e Mb:	NEGATIVO	NEGATIVO
Proteine (semiquantitative) (mg/dl):	tracce	0 150
WBC/hpf:	0-1	0 3
RBC/hpf:	0	0 3
Cilindri:	rari granulari	ASSENTI RARI
Cristalli:	ASSENTI	ASSENTI RARI
Batteri:	RARI**	ASSENTI ASSENTI
Cellule Epiteliali:	+	ASSENTI RARE
Proteine quantitative (mg/dl):	77	5 80
Creatinina (mg/dl):	89	81 431
Rapporto PU/CU:	0.9	0.1 0.5

An ultrasound was requested to check for hepatic and pancreatic pathologies

Pepe, MI, 7years

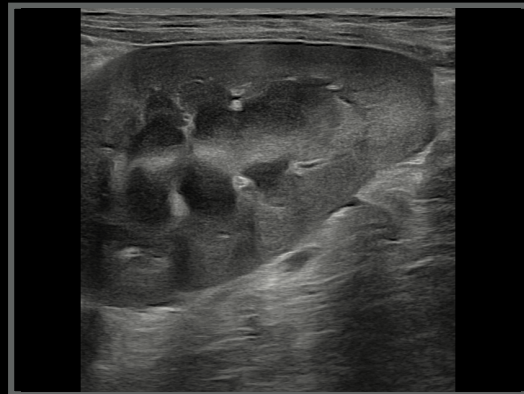
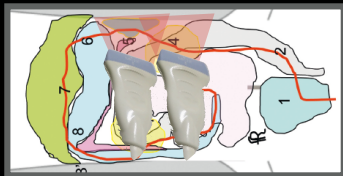
Probe position in a different patient



7

Pepe, MI, 7years

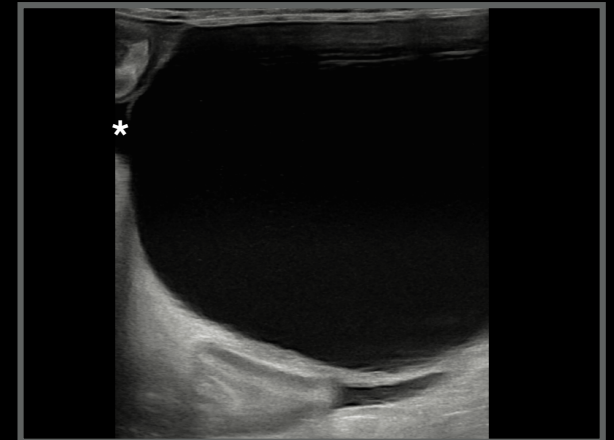
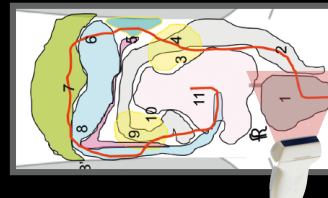
Probe position in a different patient



4

Pepe, MI, 7years

Probe position in a different patient



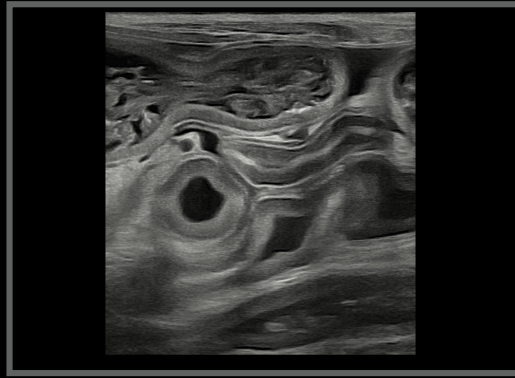
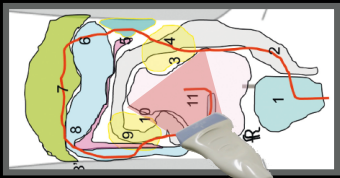
1

Pepe, MI, 7years



Probe position in a different patient

10-11

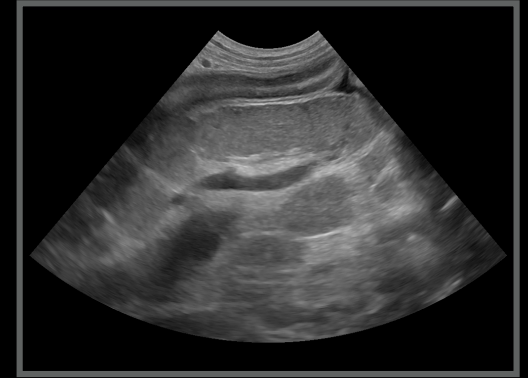
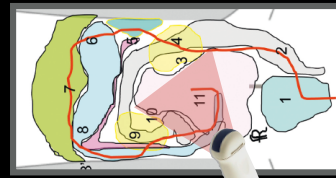


Pepe, MI, 7years



Probe position in a different patient

10-11

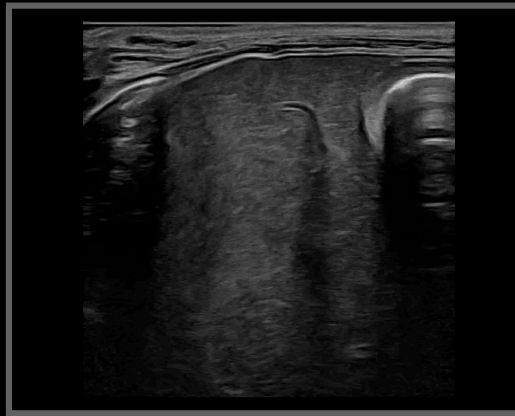


Pepe, MI, 7years



Probe position in a different patient

9-10

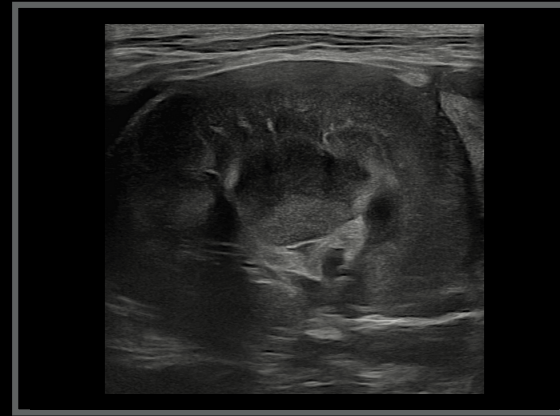
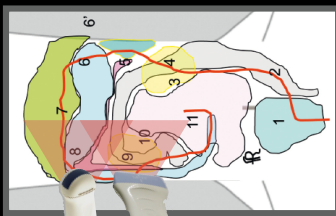


Pepe, MI, 7years



Probe position in a different patient

9-10



Pepe, Lagotto, MI, 7 years

Ultrasonographic diagnoses:

- Severe acute-on-chronic enteropathy
- Mild ascites
- Hepatopathy



Pepe, Lagotto, MI, 7 years

08/06

Follow up

- Gastroenterologist consultation
- Dietary trial
- Specific tests: (B12, folate...)
- Endoscopic biopsies



Pepe, Lagotto, MI, 7 years

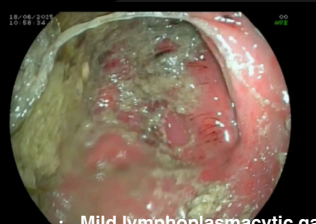
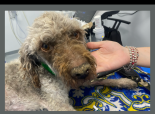
18/06

Treatment:

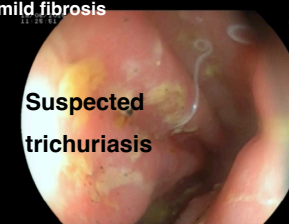
- Prednisone 1 + 1/4 cpr 20 mg BID (20/06)
- Chlorambucil 1 cpr 2 mg SID (20/06)
- B12, 1 ml (1000MCG) once week (09/06)
- Amoxicillin + Clavulanic acid 3/4 cpr 500 mg bid for 1 week (08/06)



Pepe, MI, 7 years



- Mild lymphoplasmacytic gastritis with moderate fibrosis
- Moderate lymphoplasmacytic enteritis with mild fibrosis
- Mild lymphoplasmacytic colitis with mild fibrosis



Suspected trichuriasis

Pepe, Lagotto, MI, 7 years

Five days later

- Despite treatment worsening diarrhoea
- The patient is losing weight
- Very low albumins

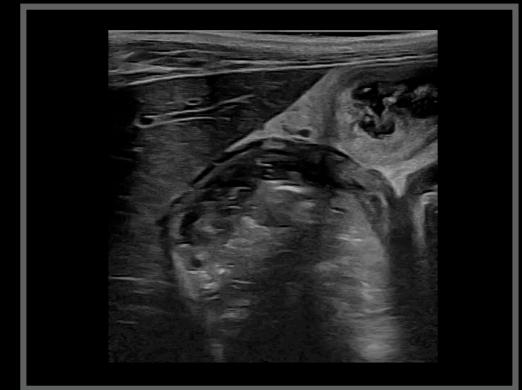


An abdominal US was requested: did we miss something?

Pepe, MI, 7 years

Five days later

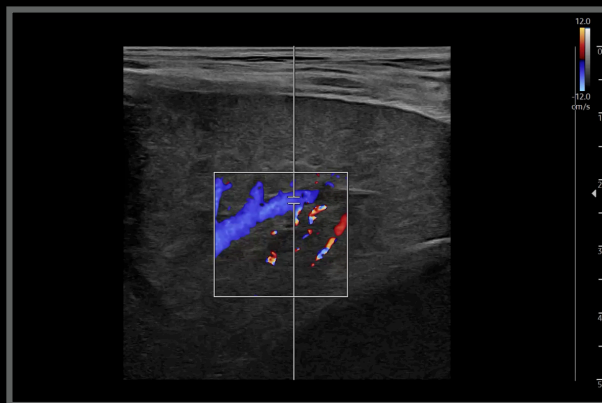
Probe position in a different patient



6

Which information the Color Doppler adds?

- It shows flow and flow direction
- Approximate flow velocity
- How does it work?

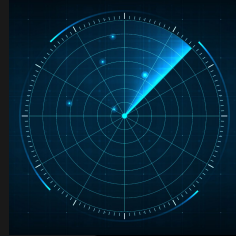


What is the Doppler effect?

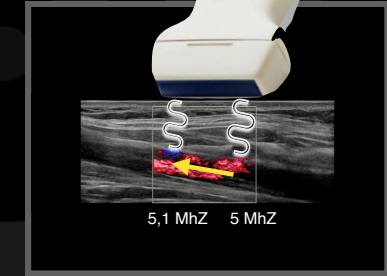
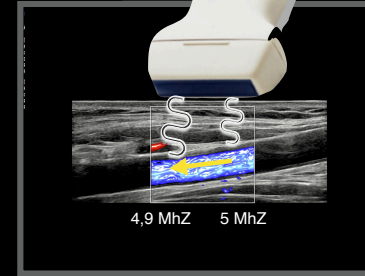
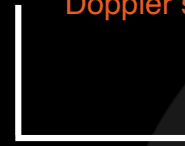
Christian Johann Doppler



Doppler effect in nature and industry



Doppler shift



Doppler Shift



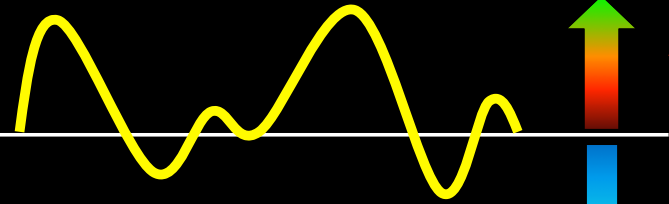
Color Doppler



+cm/s

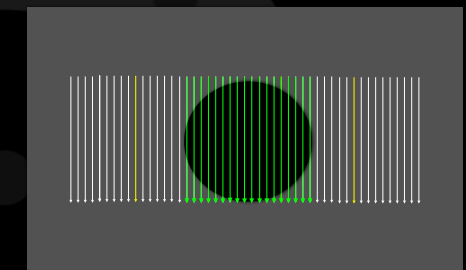
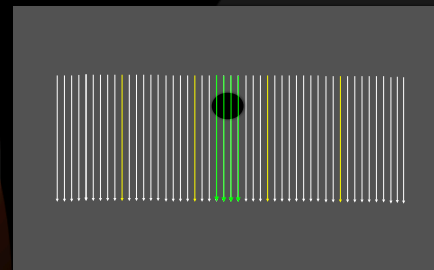
-cm/s

Pulse waves Doppler



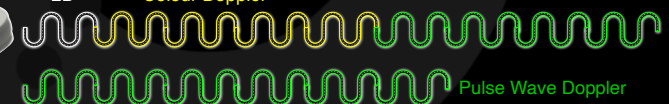
Use minimal depth!!!

We are always in a deficit of echoes, don't throw them away!



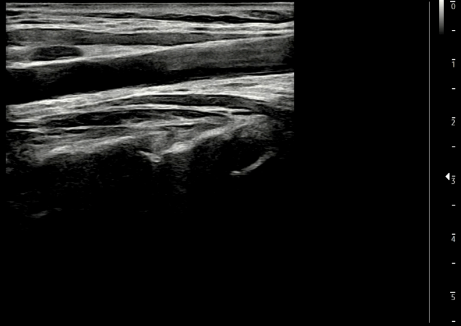
2D

Colour Doppler



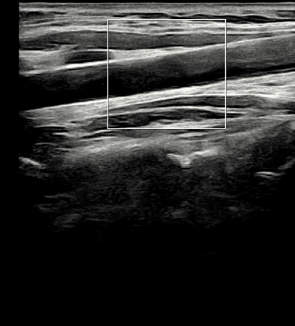
Doppler setting

- Why the Doppler is not working?



Doppler setting

- Why the Doppler is not working?
- What should we do now?



Low PRF

PRF and flow velocity have to match

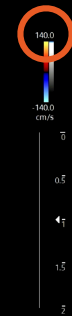
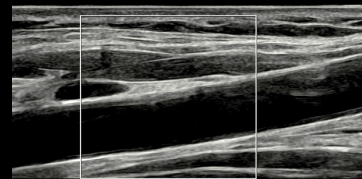


High PRF



Doppler setting

- Why the Doppler is not working?
- What should we do now?
- Are the PRF and flow velocity matching?



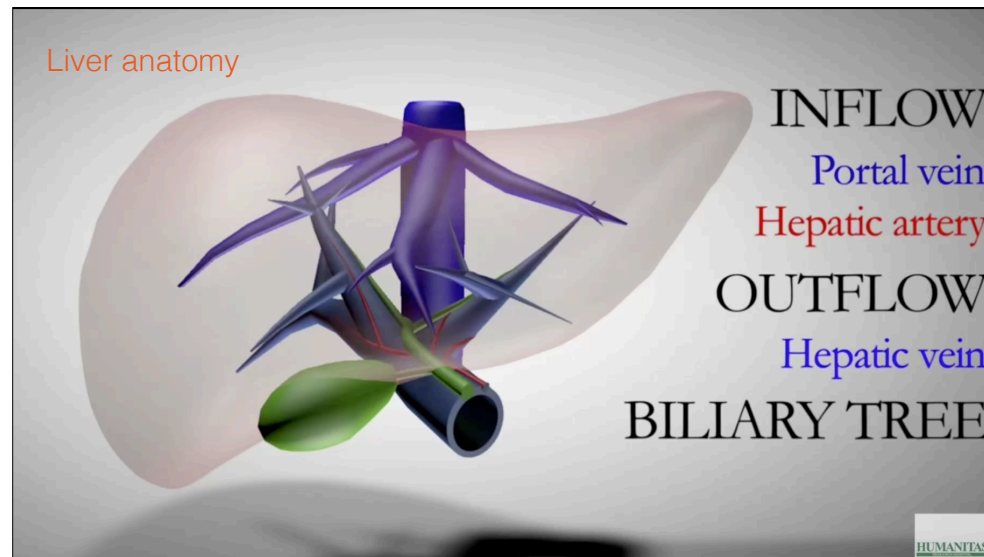
- Check the gain setting: start at 40%

Which vessels are we watching?

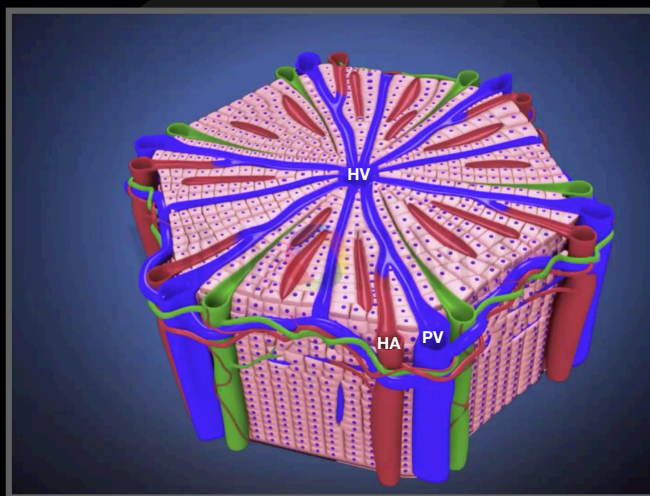
- Hepatic vein
- Portal vein
- Hepatic artery



Liver anatomy



Microscopic hepatic anatomy



PubMed search results for "hepatic arterialization dog".

Search: hepatic arterialization dog

Advanced Create alert Create RSS User Guide

Save Email Send to Sort by: Best match Display options

CUSTOM FILTERS 1,853 results Page 1 of 186

RESULTS BY YEAR

PUBLICATION DATE

1 year

5 years

Arterialization of the liver in combination with a portacaval shunt in the dog.

1 Adamsons RJ, Arif S, Babich A, Butt K, Lam A, Minkowitz S.
Cite Surg Gynecol Obstet. 1975 Apr;140(4):594-600.
PMID: 1129667

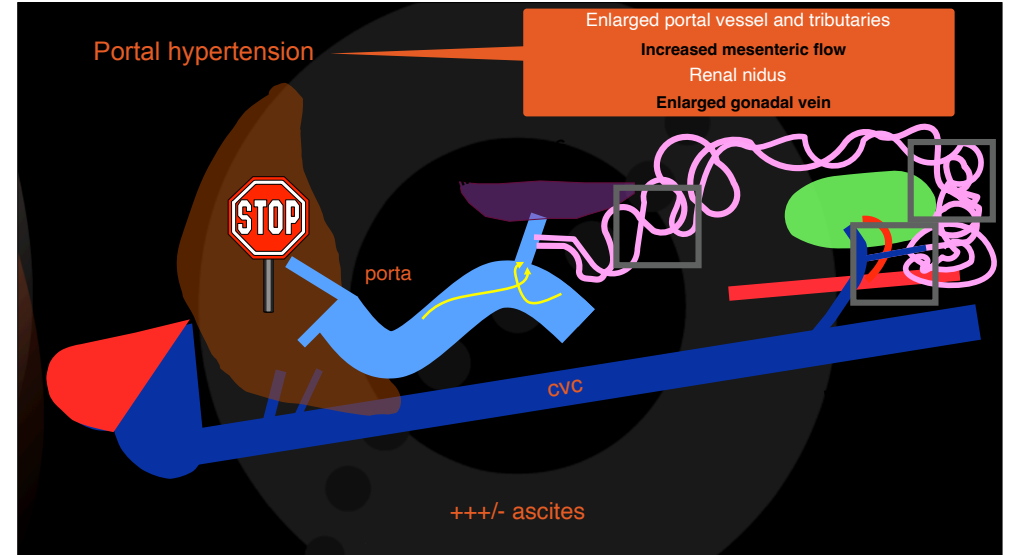
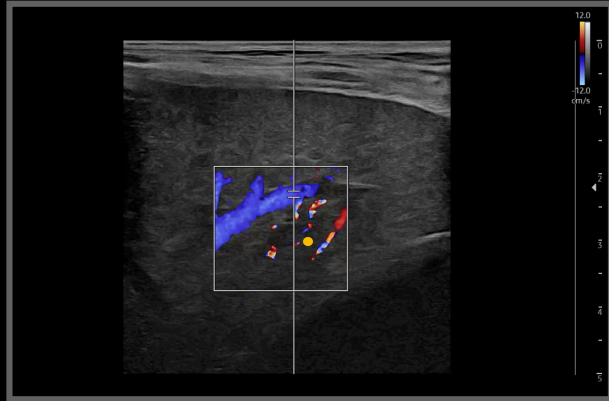
A dog preparation has been developed combining an end-to-side portacaval shunt with arterialization of the hepatic portion of the portal vein through an anastomosis between the inferior branch of the splenic artery and the stump of the portal vein. In ...

Hepatic artery aneurysm.

2 Erskine JM.
Cite Vasc Surg. 1973 Mar;7(2):106-25. doi: 10.1177/153857447300700205.
PMID: 4572558 Review. No abstract available.

Why the hepatic artery is enlarged?

- Insufficient portal flow
- Congenital PPS
- **Portal hypertension**
- Portal thrombosis
- Pregnancy



Pulsed Doppler Ultrasonographic Evaluation of Portal Blood Flow in Dogs with Experimental Portal Hypertension after Ligature

Young-won LEE
 Veterinary Medical Teaching Hospital, School of Veterinary Medicine, Seoul National University, San 56-1, Shilm-dong, Kwanak-ku, Seoul, 151-742, Korea
 (Received 9 September 1998/Accepted 9 September 1999)

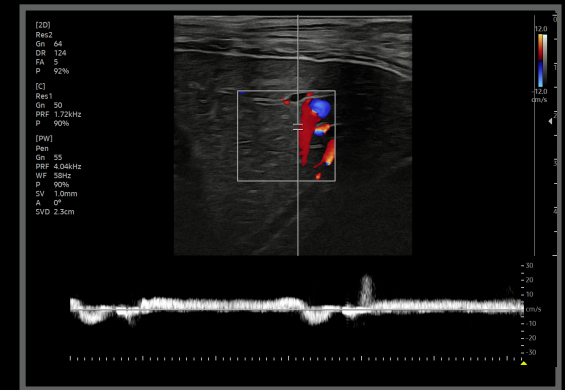
ABSTRACT: Portal blood flow was measured using pulsed Doppler ultrasonography before and after left portal vein branch ligation. Mean portal vein blood flow velocity and mean portal vein blood flow were significantly reduced after ligation and the congestion index was increased ($p < 0.01$). Pulsed Doppler ultrasound studies provide useful information which may assist the clinician with the diagnosis of canine hepatic circulatory disorders.—**KEY WORDS:** canine, portal hypertension, portal blood flow.

The transducer was placed at the 9th to 11th intercostal spaces. The Doppler cursor was placed in the mid lumen of the portal vein. Three measurements were taken from each dog at an optimal acoustic window of the portal vein. The angle of insonation was always less than 70°. The length of sample volume was approximately half the diameter of the vessel. Pulse repetition frequency of 3.0 kHz was used and the cross sectional area of the portal vein was calculated from the vessel diameter as measured on transverse scans at right angles to the vessel wall. The maximal velocity method was used to calculate flow volume in this study. The congestion index was calculated by dividing the portal vein area by the portal blood flow velocity [9].

Pepe, MI, 7years

Five days later

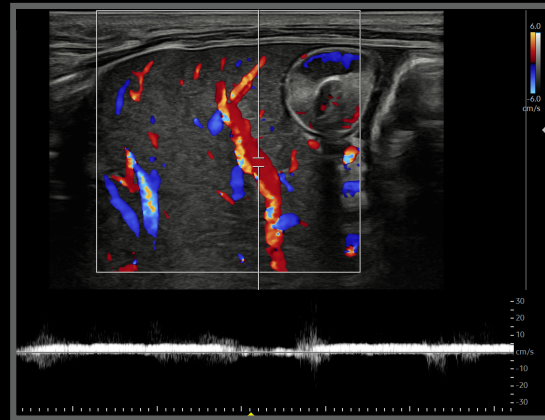
Probe position in a different patient



Portal hypertension



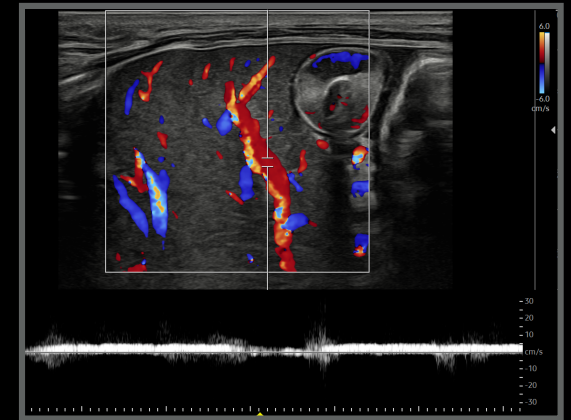
- Low portal velocity
- Where should I check the portal velocity?
- How accurate it is?



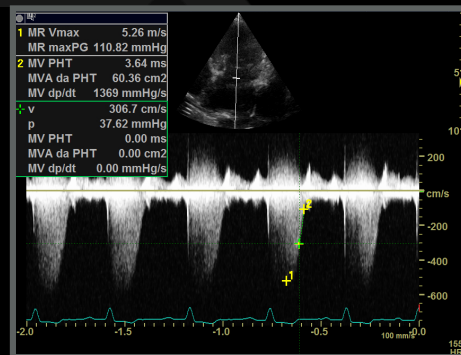
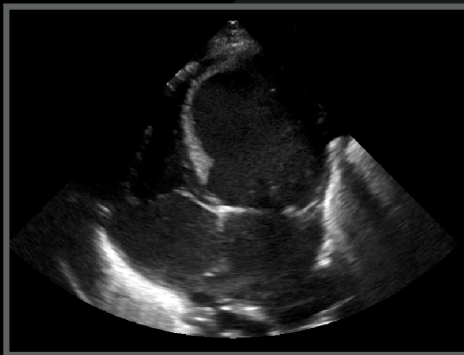
Portal hypertension



- The most parallel to the probe vessel is the best
- Do not change the angle (it will increase the error)
- Normal velocity: 10-20 cm/s
- Consider velocity < 5 cm/s



Echocardiography



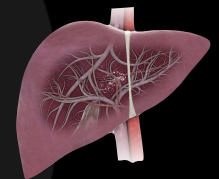
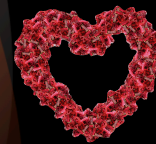
This formula applies only to STENOSIS

$$V^2 \times 4 = P \quad V \text{ proportional } P$$

Partially close the tube with your finger

PW Doppler

Totally close the tube with your finger



V proportional P

V inversely proportional P

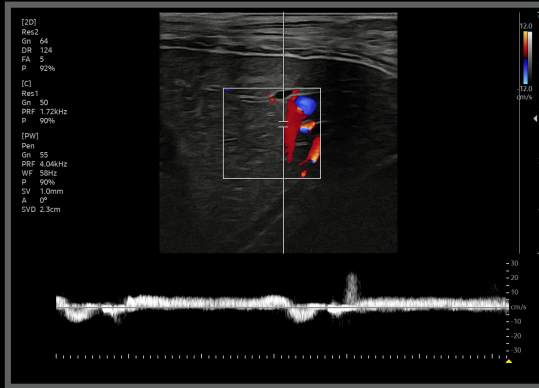
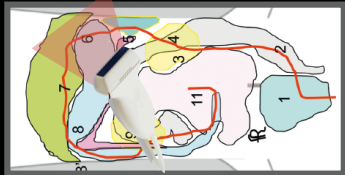
Pepe, MI, 7years

Five days later



Probe position in a different patient

6



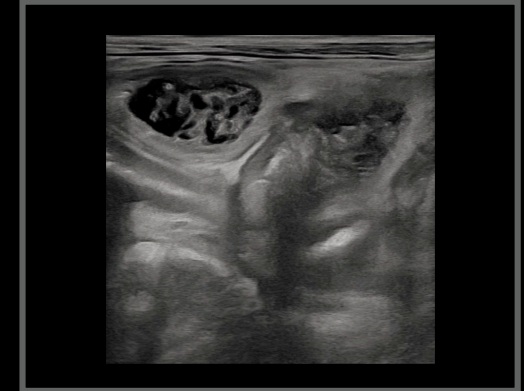
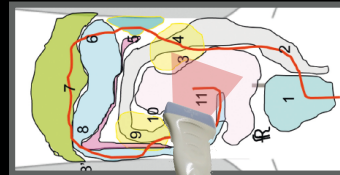
Pepe, MI, 7years

Five days later



Probe position in a different patient

7-11



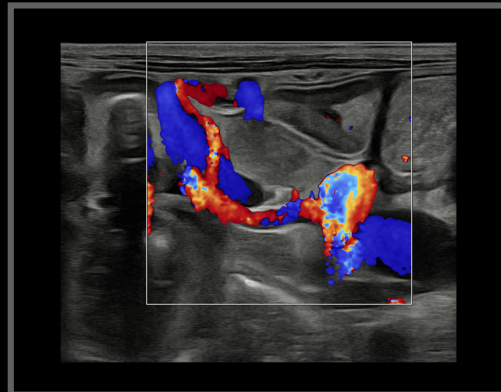
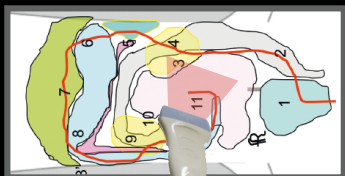
Pepe, MI, 7years

Five days later



Probe position in a different patient

5-11



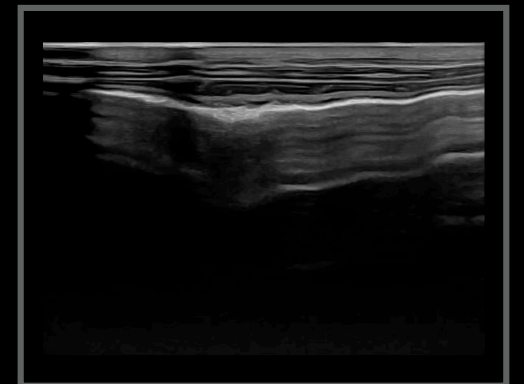
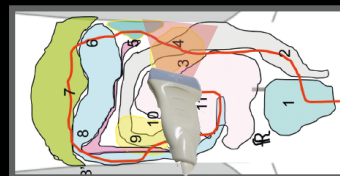
Pepe, MI, 7years

Five days later



Probe position in a different patient

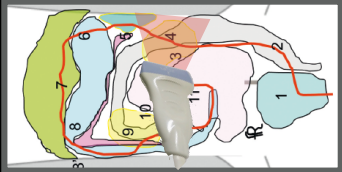
3-4



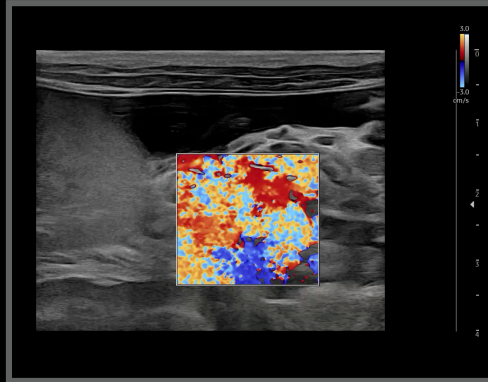
Pepe, MI, 7years

Five days later

Probe position in a different patient



How to improve the Color Doppler?

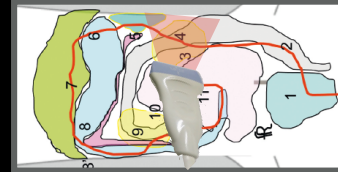


3-4

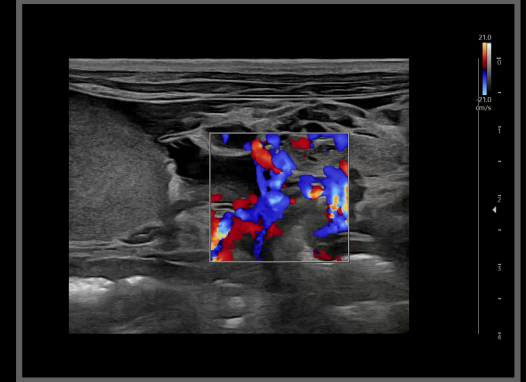
Pepe, MI, 7years

Five days later

Probe position in a different patient

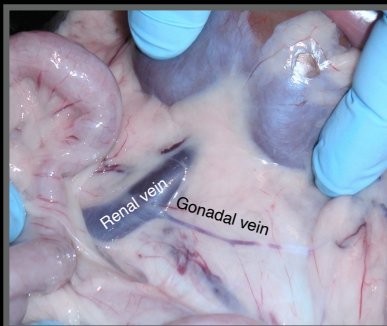


3-4

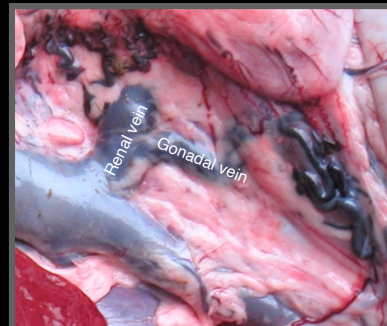


Thanks to Viktor Szatmari

Normal portal pressure



Portal hypertension



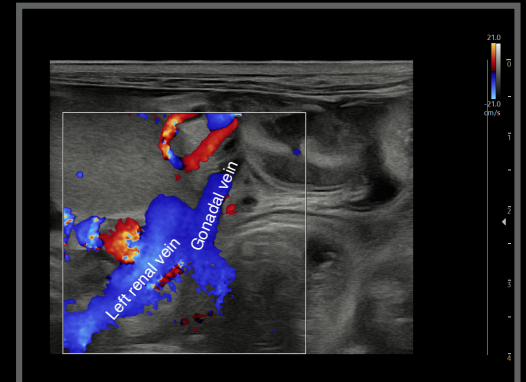
Pepe, MI, 7years

Five days later

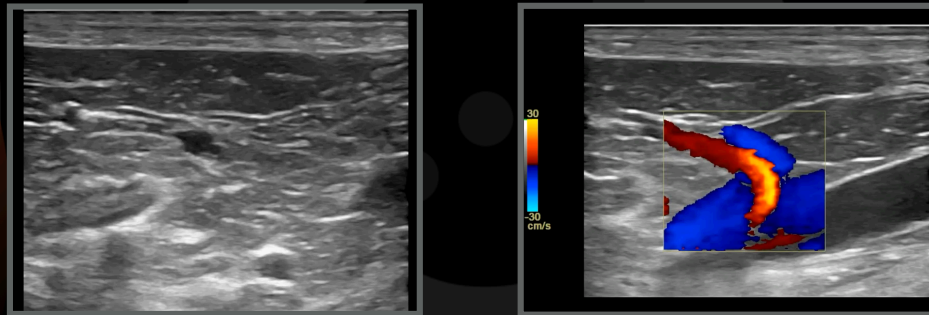
Probe position in a different patient



3-4



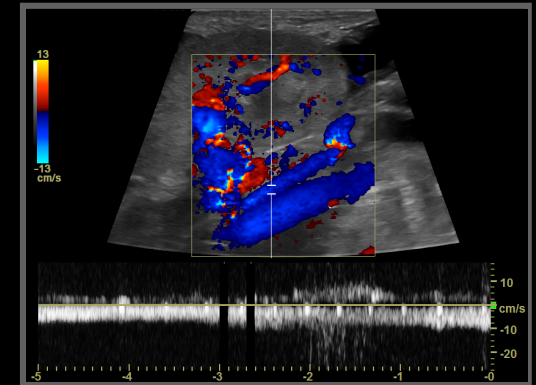
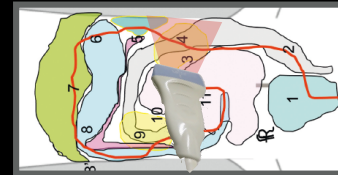
Left renal vein - gonadal vein



Cora, FI, 12 years

Probe position in a different patient

4

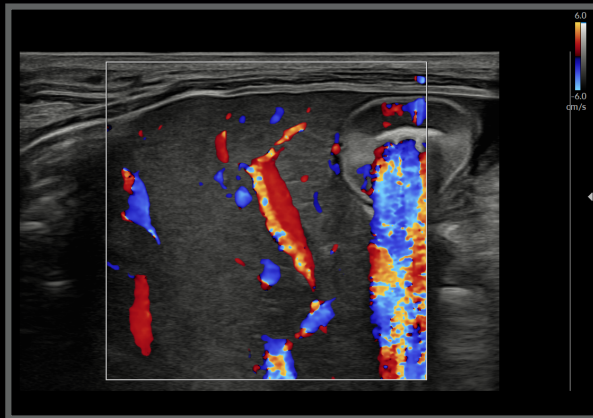
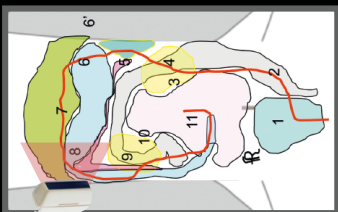


Pepe, MI, 7years

Five days later

8'

Probe position in a different patient

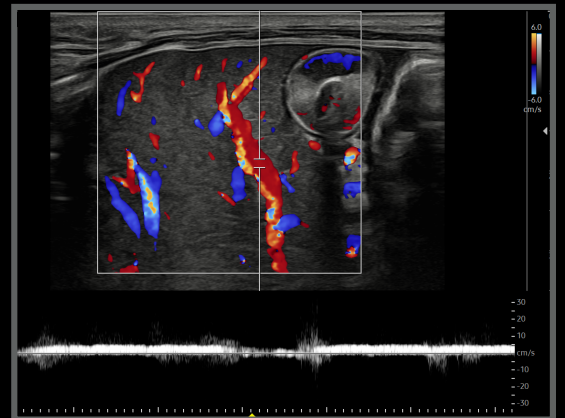
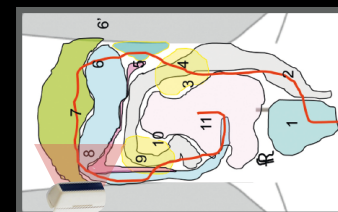


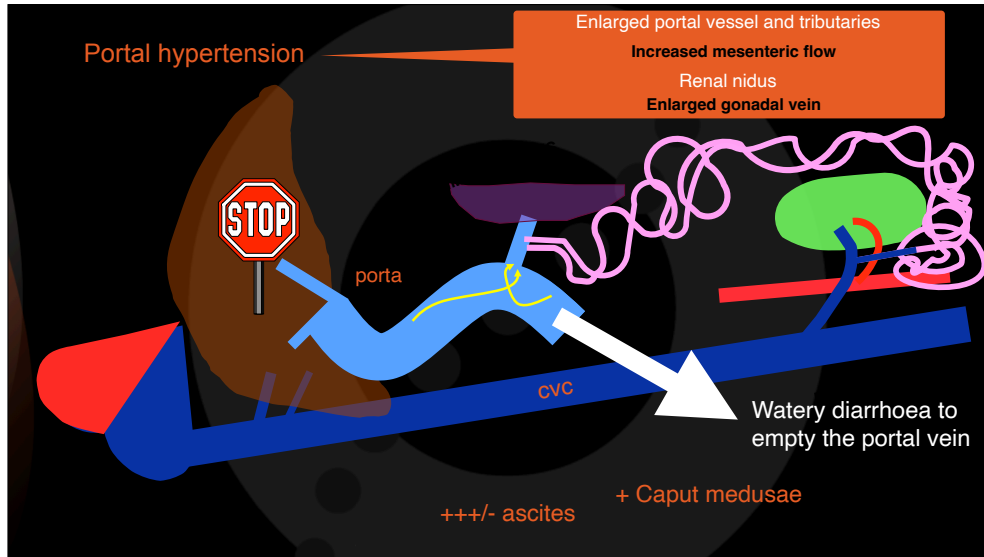
Pepe, MI, 7years

Five days later

8'

Probe position in a different patient





The “caput medusae” sign in portal hypertension

Abdom Radiol (2018)
<https://doi.org/10.1007/s00261-018-1493-4>

Dario Giambelluca, Giovanni Caruana, Roberto Cannella, Dario Picone, Massimo Midiri

Section of Radiological Sciences, Di.Bi.Med., University of Palermo, Via del Vespro 127, 90127 Palermo, Italy

The “caput medusae” sign results from reopening of paraumbilical veins that shunt blood from portal vein into systemic circulation (mainly through connections with epigastric veins). Paraumbilical veins appear as multiple serpentine structures, usually remaining asymptomatic, so that they may be discovered incidentally on abdominal imaging performed in cirrhotic patients [1]. However, several cases of hemorrhage from recanalized paraumbilical veins were described in literature [3].

Pepe, Lagotto, MI, 7 years

23/06

- Portal hypertension
- Ascites
- Acquired PPS
- Caput medusa

Pepe, Lagotto, MI, 7 years

Nineteen days later

- Medical treatment for end stage portal hypertension
- Euthanised for seizures due to hepatic encephalopathy

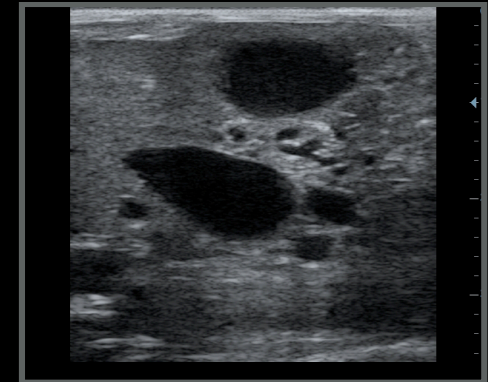
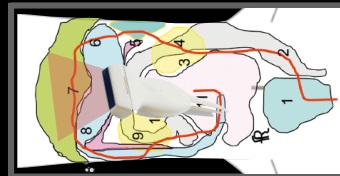
Sasha, DSH, FI, 2 months

- Lethargic
- Anorexia
- Recurrent watery diarrhoea



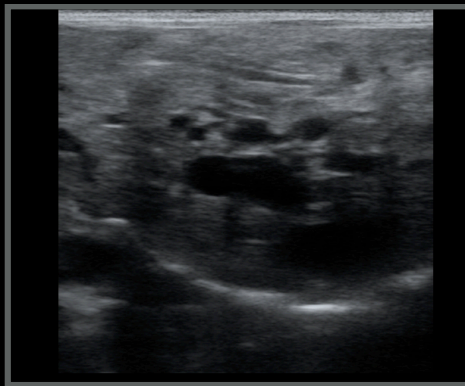
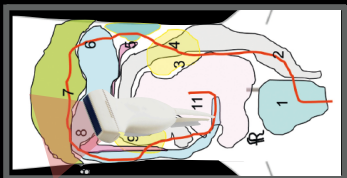
Sasha, FI, 2 months

Probe position in a different patient



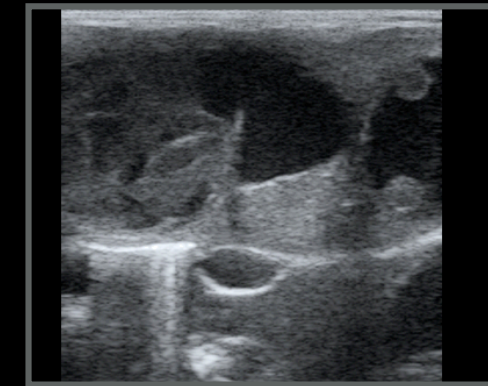
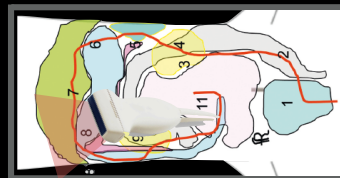
Sasha, FI, 2 months

Probe position in a different patient



Sasha, FI, 2 months

Probe position in a different patient



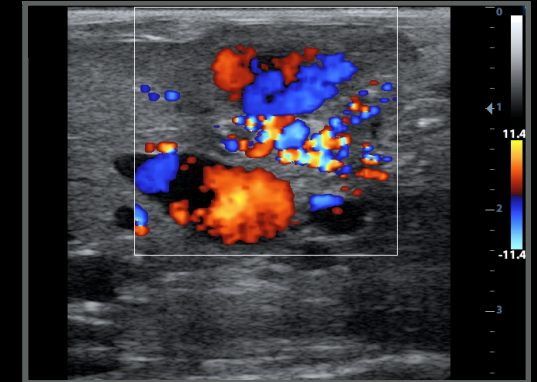
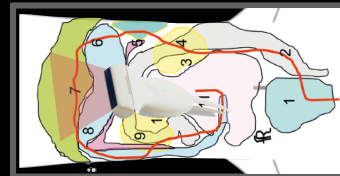
Could Sasha have a portosystemic shunt?

Congenital or acquired?

What is the most likely diagnosis?

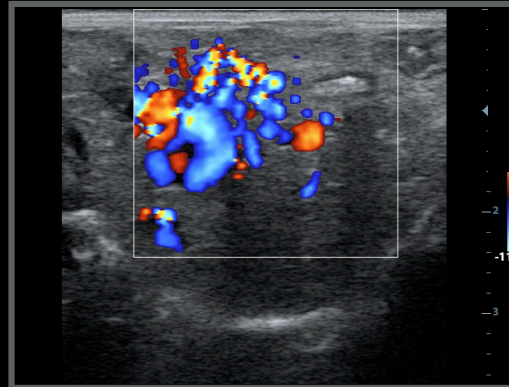
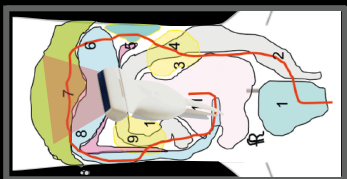
Sasha, FI, 2 months

Probe position in a different patient



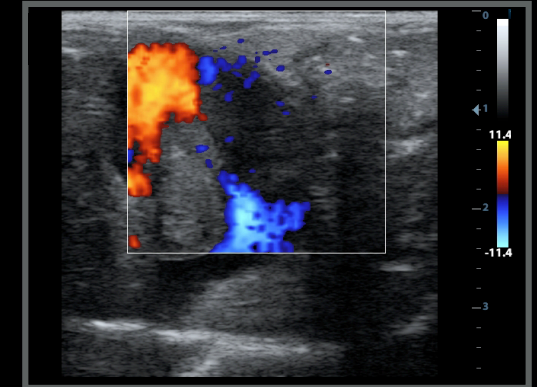
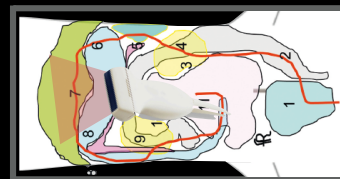
Sasha, FI, 2 months

Probe position in a different patient



Sasha, FI, 2 months

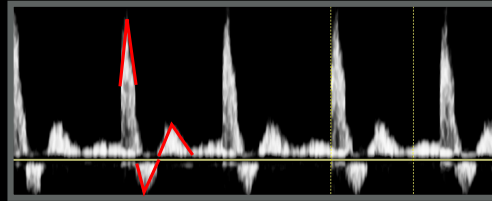
Probe position in a different patient





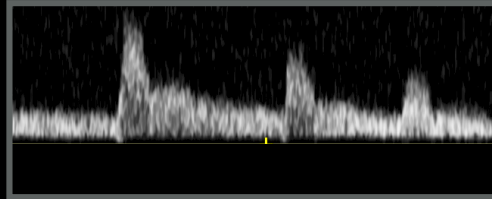
Aortic flow

High peripheral resistance

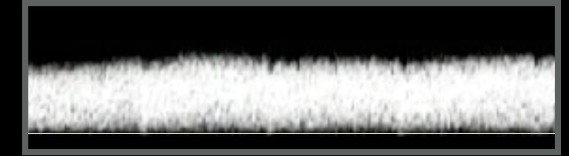


Renal artery

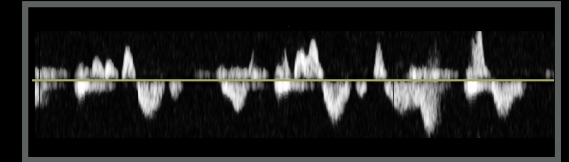
Reduced peripheral resistance



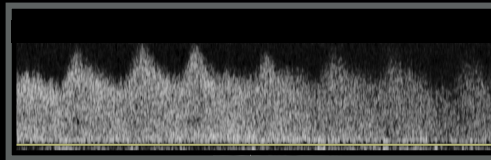
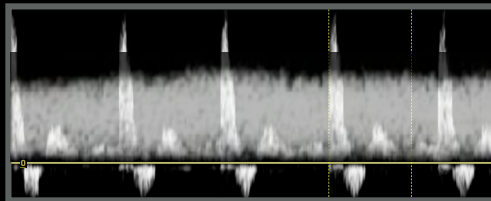
Portal flow



Caudal Vena Cava flow

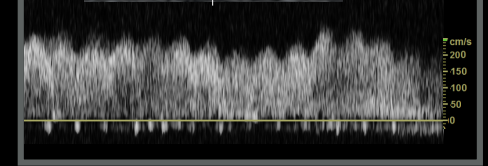
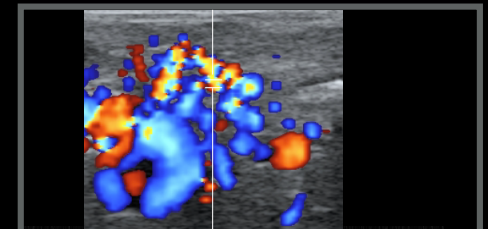
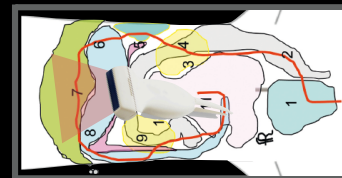


Artero-venous malformation



Sasha, FI, 2 months

Probe position in a different patient



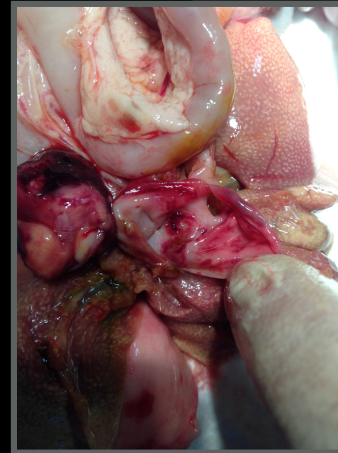
Sasha, DSH, FI, 2 months

Ultrasonographic diagnoses

- Artero-portal malformation
- Suspected portal vein thrombosis
- Owner declined treatment

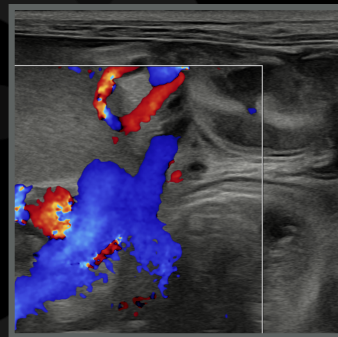


Sasha, FI, 2 months



Conclusions

- Color Doppler should be routinely applied to the liver, spleen and kidneys
- Learning curve of one year
- A solid understanding of pathophysiology is essential



Thank you



Diagnostic Mindset

www.diagnosticmindset.com