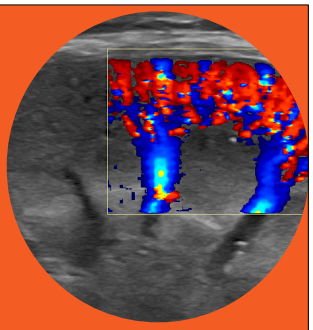
Advanced vascular ultrasound with focus in portal hypertension

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



Diagnostic Mindset

Clinica Veterinaria CASTELLARANO

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 i/µL) :	5.73	5.70	8.56	Acantociti:		Eliptociti:	
HGB (g/dL) :	13.6	14.1	21.2	Anisocitosi:		Ipocromia:	
HCT (%) :	38.8	39.0	59.2	Agglutinazione:		Macrociti:	
MCV (fL) :	67.8	63.1	72.6	Codociti:		Microciti:	
MCH (pg) :	23.8	21.8	25.4	Cheratociti:		Parassiti eritrocitari:	
MCHC (g/dL) :	35.1	33.3	36.8	Cnizociti:		Policromasia:	
CHCM (g/dL) :		34.3	37.8	Corpi di Heinz:		Punteggiature basofile:	
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	Drepanociti:		Sferociti:	
HDW (g/dL) :		1.63	2.22	Eccentrociti:		Stomatociti:	
NRBC/100 WBC:	0	0	0	Echinociti:	+	Torociti:	
Varie RBC:							
WBC (x 1000 i/µL) :	32.6	5.45	12.98	Linfociti attivati:			
Conta corr. WBC (x 1000 i/µL) :		5.45	12.98	Linfociti atipici:			
Mielociti (i/µL) :	0	0	0	Neutrofili tossici:	-		
Metamielociti (i/µL) :	0	0	0	Corpi di Doehle:			
Neutrofili banda (i/µL) :	326	0	286	Schiumosità citopl.:			
Neutrofili segmentati (i/µL) :	30644	3555	9314	Vacuolizzazione citopl.:			
Linfociti (i/µL) :	652	1169	3810	Basofilia citopl.:			
Monociti (i/µL) :	652	186	798	Granuli tossici:			
Eosinofili (i/µL) :	326	104	1164	Neutrofili giganti:			
Basofili (i/µL) :	0	0	106	Macropoliciti:			
Danneggiate (i/µL) :	0	0	0				
Indifferenziate (i/µL) :	0	0	0				
Altre (i/µL) :	0	0	0				
Varie WBC:							
PLT (1000 i/µL) :	238	176	479	Stima PLT:	ADEG.: ☑	INADEG.: ☐	AUMENT.: ☐
MPV (fL) :	6.7	8.9	15.0	Varie:	Piastrine attivate: ☐		Macropiastrine: ☑
PCT (%) :	0.160	0.21	0.52		Piastrine allungate: ☐		Inclusi piastrinici: ☐
PDW (%) :	10.1	51.8	74.5				

Pepe, MI, 7 years

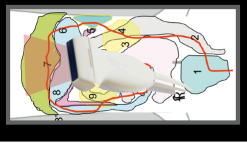
CPK (IU/L):	1238	42-155
AST (IU/L):	168	20-50
ALT (IU/L):	112	15-50
ALP (IU/L):	353	20-110
GGT (IU/L):	9.6	1-11
Colinesterasi (IU/L):		3347-7074
Bilirubina Totale (mg/dL):	0.17	0.15-0.4
Proteine Totali (g/dL):	5.0	5.5-7.5
Albumine (g/dL):	2.1	2.7-3.6
Globuline (g/dL):	2.9	2.6-3.9
Rapporto A/G:	0.72	0.7-1.2
Colesterolo (mg/dL):	108	150-350
Trigliceridi (mg/dL):	50	30-110
AMILASI (IU/L):	5073	300-1800
Lipasi (dggr) (UI/L):	979	29-143
Urea (mg/dL):	39	18-45
Creatinina (mg/dL):	0.50	0.75-1.3
Glucosio (mg/dL):	15	60-100
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

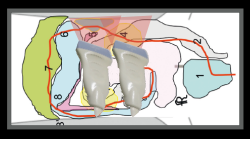
Probe position in a different patient



Pepe, MI, 7years

Probe position in a different patient

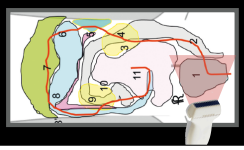
4

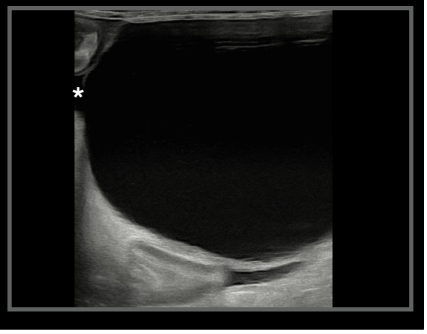


Pepe, MI, 7years

Probe position in a different patient

1

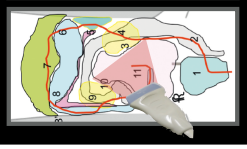


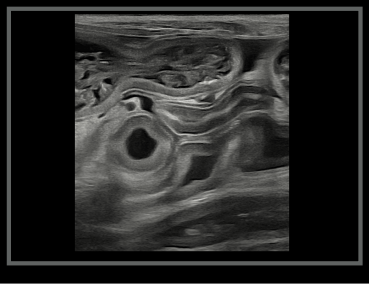


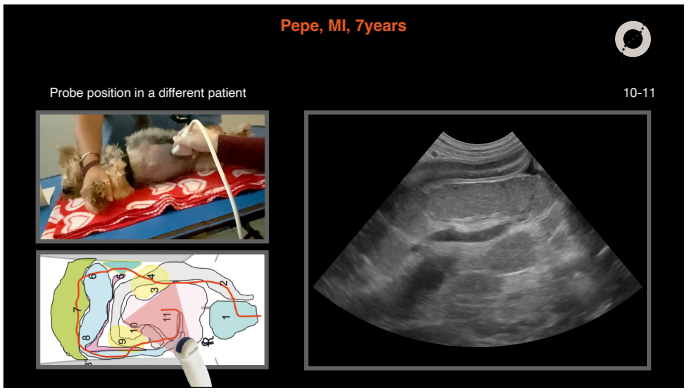
Pepe, MI, 7years

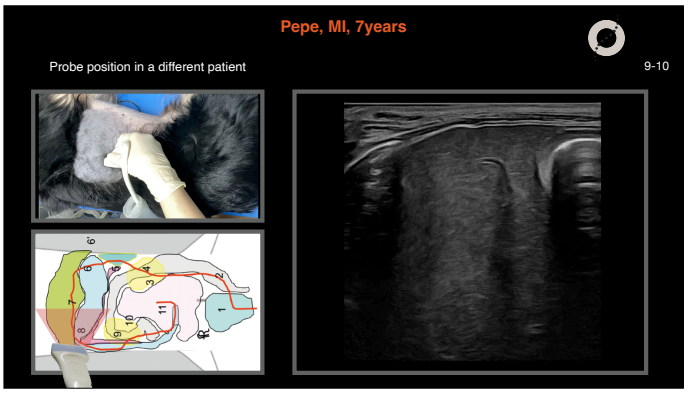
Probe position in a different patient

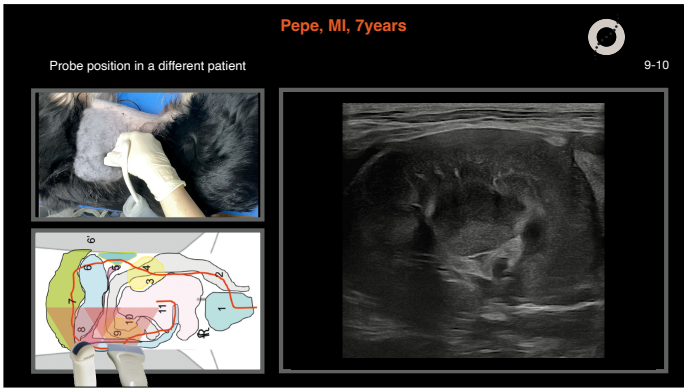
10-11






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

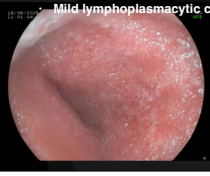
08/06

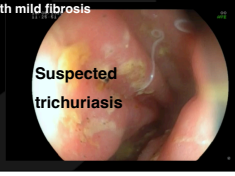
Follow up

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

Pepe, 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

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, Lagotto, MI, 7 years

Five days later

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

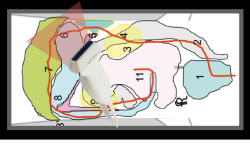
An abdominal US was requested: did we miss something?

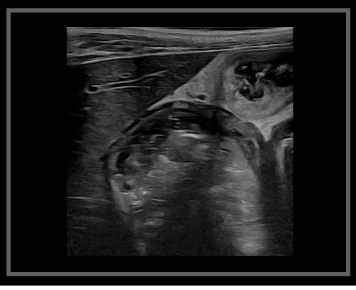
Pepe, MI, 7years

Five days later

Probe position in a different patient

6





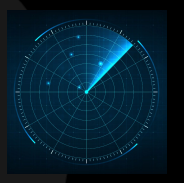
Which information the Color Doppler adds?

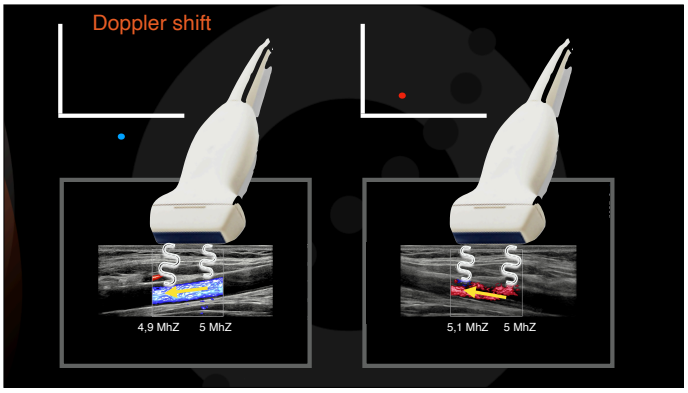
- It shows flow and flow direction
- Approximate flow velocity
  - How does it work?

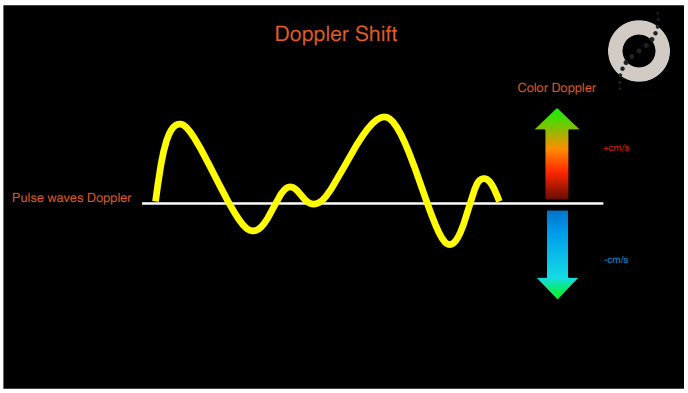
What is the Doppler effect?

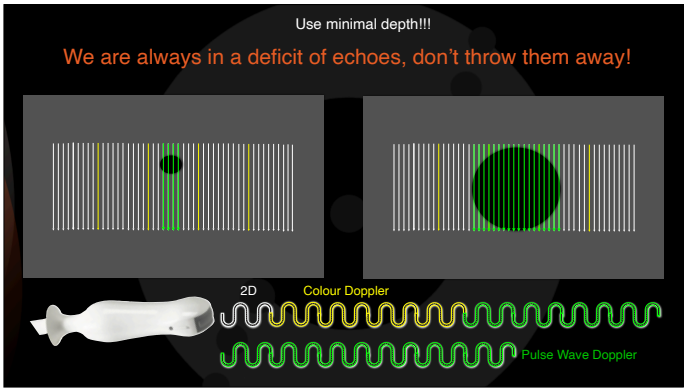
Christian Johann Doppler

Doppler effect in nature and industry



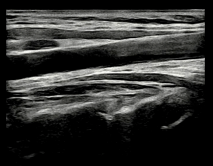

Doppler shift
4,9 MhZ
5 MhZ
5,1 MhZ
5 MhZ


Doppler Shift
Color Doppler
+cm/s
Pulse waves Doppler
-cm/s


Use minimal depth!!!
We are always in a deficit of echoes, don't throw them away!
2D
Colour Doppler
Pulse Wave Doppler

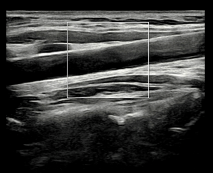
Doppler setting

- Why the Doppler is not working?



Doppler setting

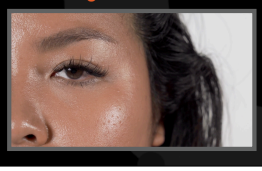
- Why the Doppler is not working?
- What should we do now?



Low PRF

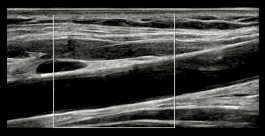
PRF and flow velocity have to match

High PRF



Doppler setting

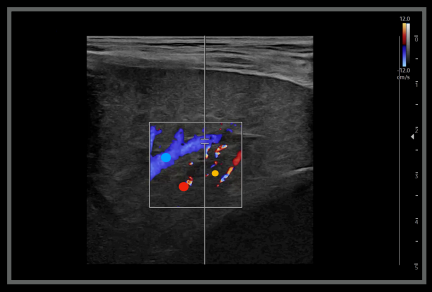
- Why the Doppler is not working?
- What should we do now?



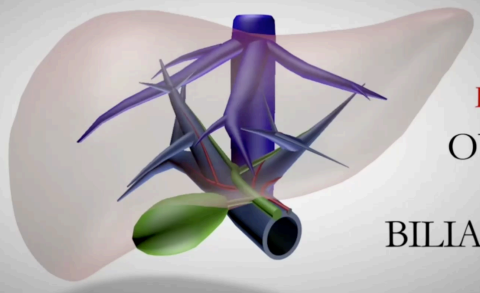
- Are the PRF and flow velocity matching?
- Check the gain setting: start at 40%

Which vessels are we watching?

- Hepatic vein
- Portal vein
- Hepatic artery



Liver anatomy



INFLOW

Portal vein

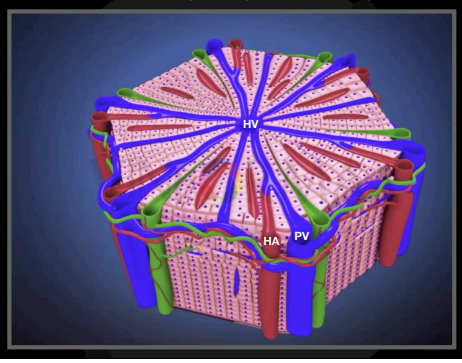
Hepatic artery

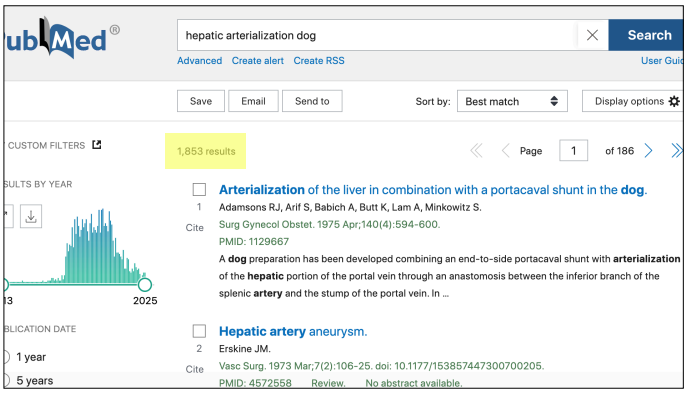
OUTFLOW

Hepatic vein

BILIARY TREE

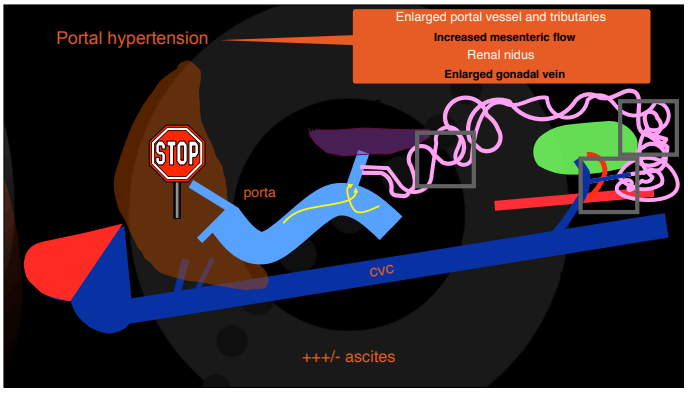
Microscopic hepatic anatomy

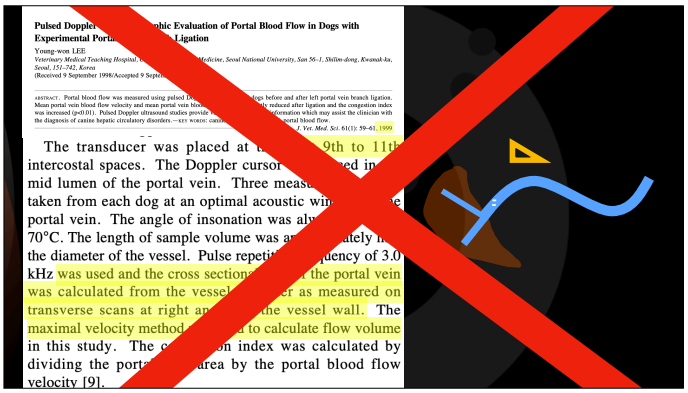


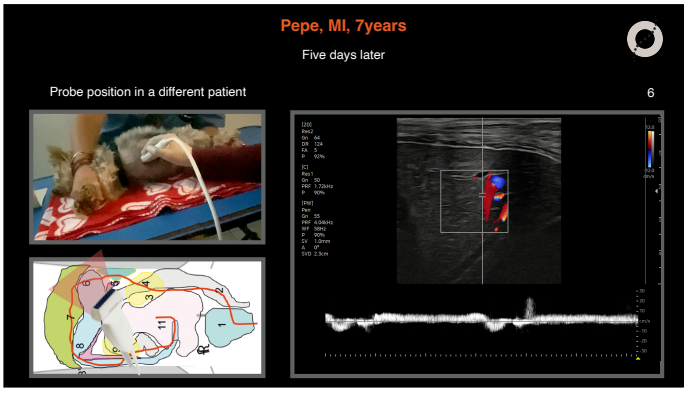


Why the hepatic artery is enlarged?

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

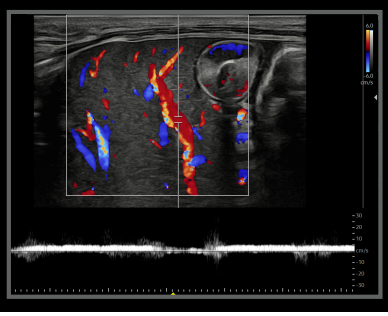

Portal hypertension
Enlarged portal vessel and tributaries
Increased mesenteric flow
Renal nidus
Enlarged gonadal vein
STOP
porta
cvc
+++/- ascites


Pulsed Doppler
hic Evaluation of Portal Blood Flow in Dogs with
Experimental Porta
Ligation
Young-won LEE
The transducer was placed at t
9th to 11th
intercostal spaces. The Doppler cursor
ed in
mid lumen of the portal vein. Three measu
taken from each dog at an optimal acoustic win
portal vein. The angle of insonation was alw
70°C. The length of sample volume was a
ately
the diameter of the vessel. Pulse repeti
uency of 3.0
kHz was used and the cross section
the portal vein
was calculated from the vessel
er as measured on
transverse scans at right an
the vessel wall. The
maximal velocity method
to calculate flow volume
in this study. The c
on index was calculated by
dividing the port
area by the portal blood flow
velocity [9].


Pepe, MI, 7years
Five days later
Probe position in a different patient
6

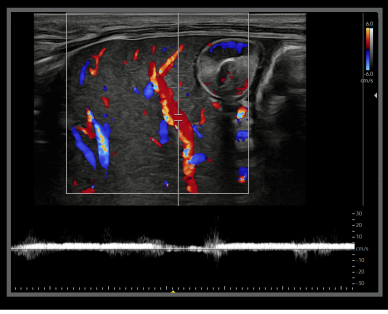
Portal hypertension

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

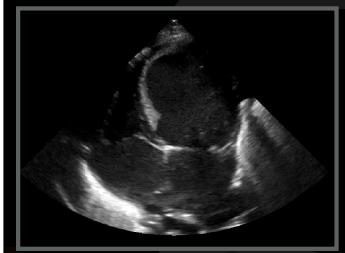


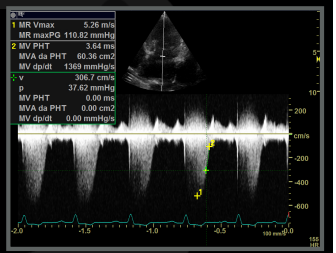
Portal hypertension

- 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

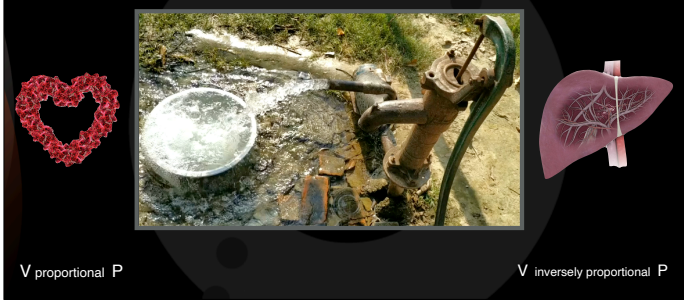
$V^2 \times 4 = P$

V proportional P

Partially close the tube with your finger

PW Doppler

Totally close the tube with your finger



V proportional P

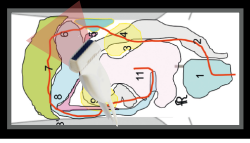
V inversely proportional P

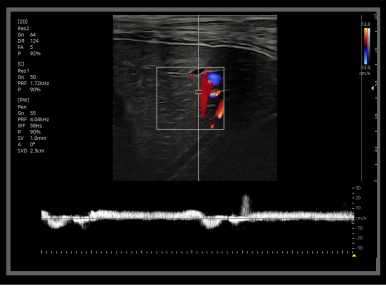
Pepe, MI, 7years

Five days later

Probe position in a different patient

6



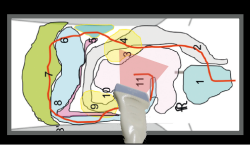


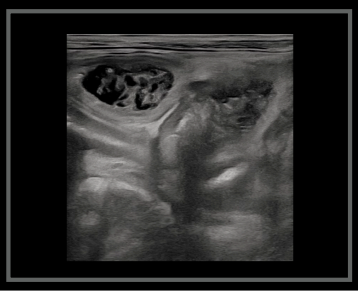
Pepe, MI, 7years

Five days later

Probe position in a different patient

7-11



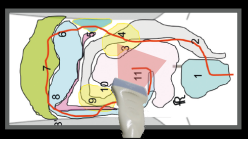


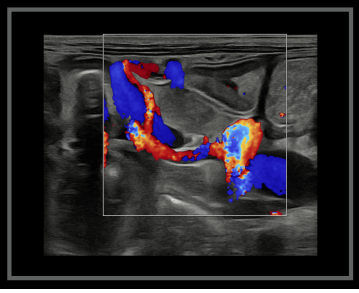
Pepe, MI, 7years

Five days later

Probe position in a different patient

5-11



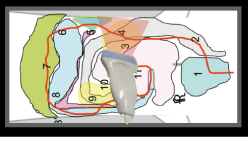


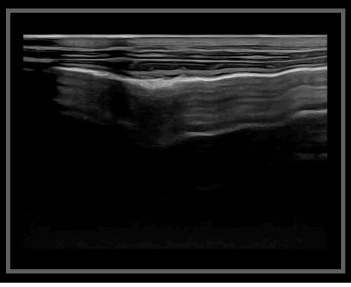
Pepe, MI, 7years

Five days later

Probe position in a different patient

3-4





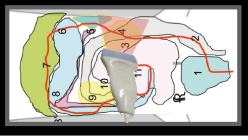
Pepe, MI, 7years

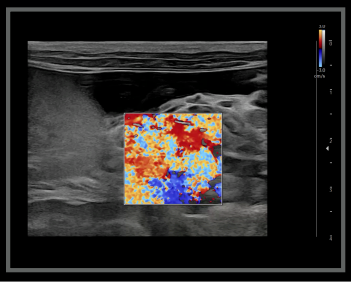
Five days later

Probe position in a different patient

How to improve the Color Doppler?

3-4



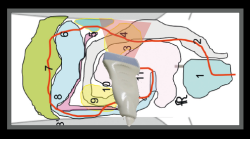


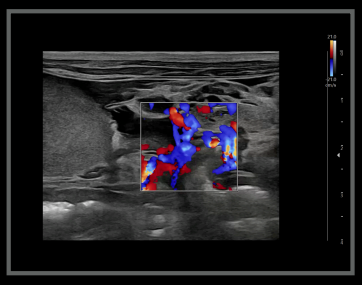
Pepe, MI, 7years

Five days later

Probe position in a different patient

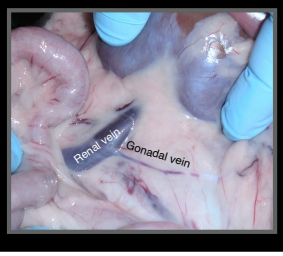
3-4



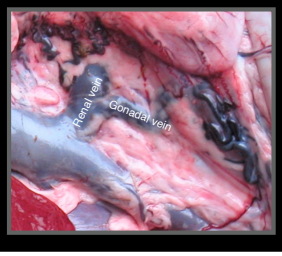


Thanks to Viktor Szatmari

Normal portal pressure



Portal hypertension

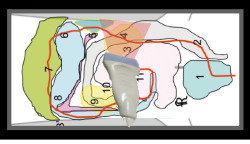


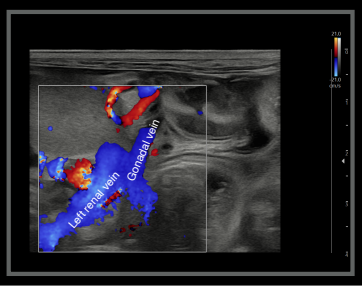
Pepe, MI, 7years

Five days later

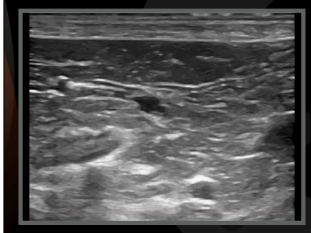
Probe position in a different patient

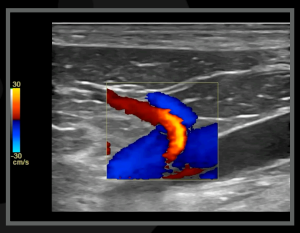
3-4





Left renal vein - gonadal vein

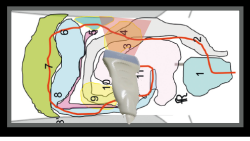


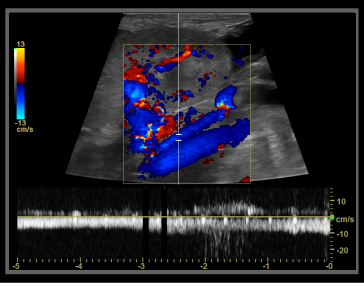


Cora, FI, 12 years

Probe position in a different patient

4



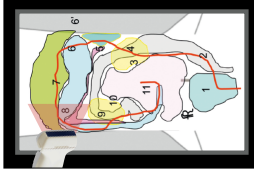


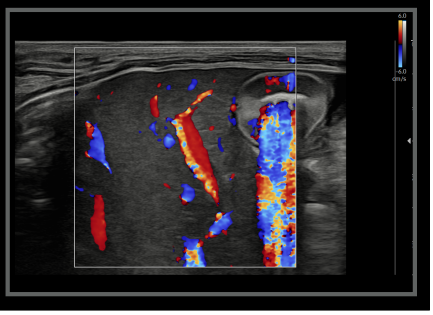
Pepe, MI, 7years

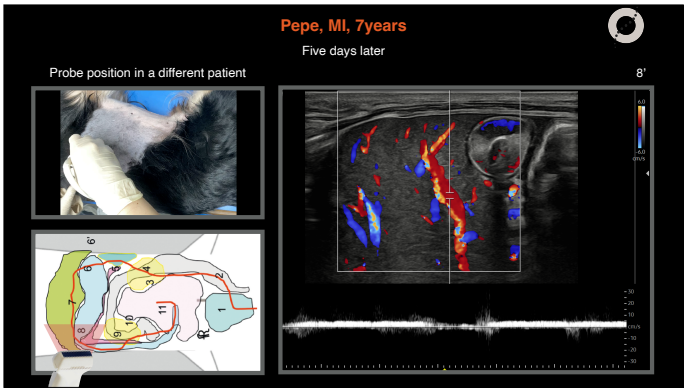
Five days later

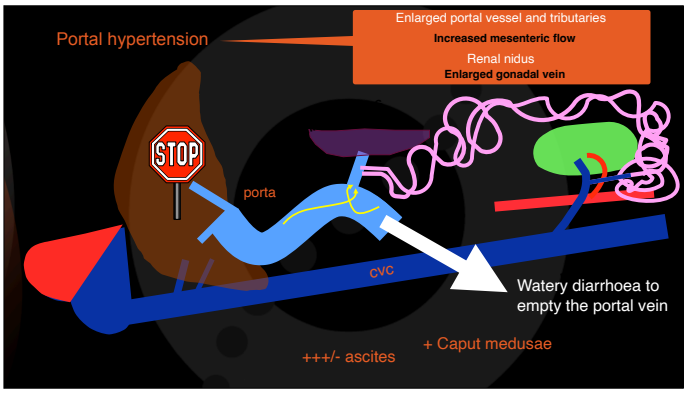
Probe position in a different patient

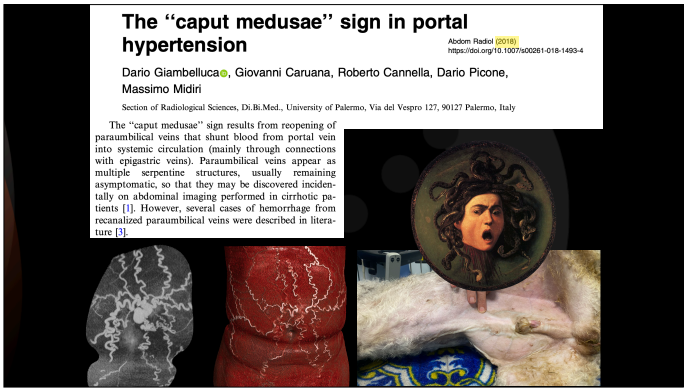
8'











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

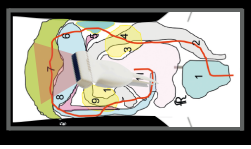
Sasha, DSH, FI, 2 months

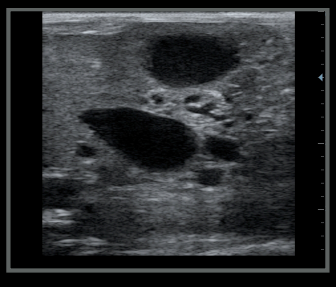
- Lethargic
- Anorexia
- Recurrent watery diarrhoea

Sasha, FI, 2 months

Probe position in a different patient

7

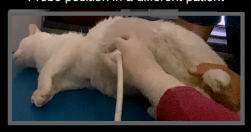


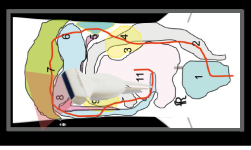


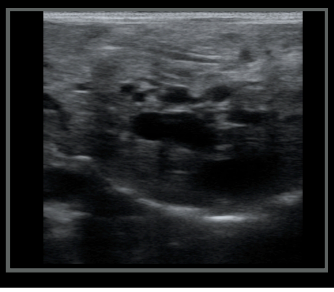
Sasha, FI, 2 months

Probe position in a different patient

7



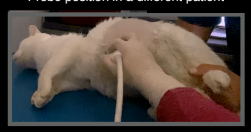


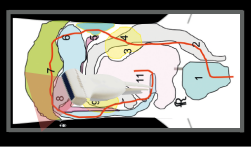


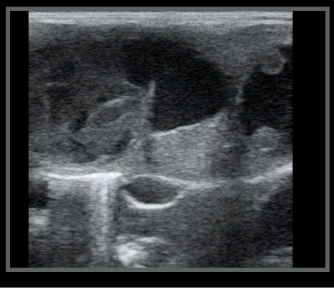
Sasha, FI, 2 months

Probe position in a different patient

7







Could Sasha have a portosystemic shunt?

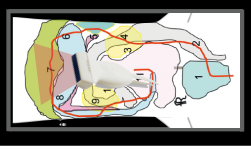
Congenital or acquired?

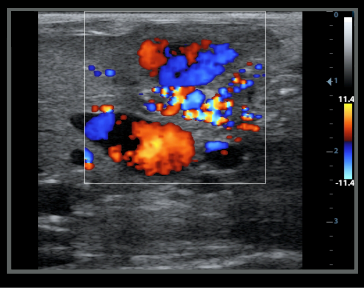
What is the most likely diagnosis?

Sasha, FI, 2 months

Probe position in a different patient

7

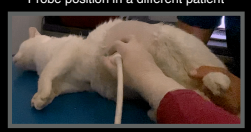


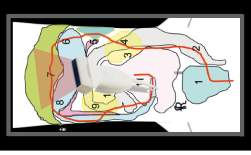


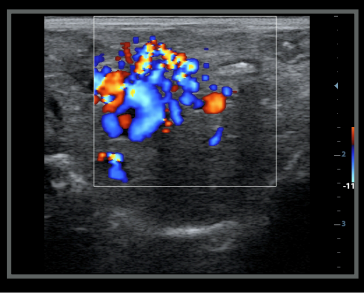
Sasha, FI, 2 months

Probe position in a different patient

7

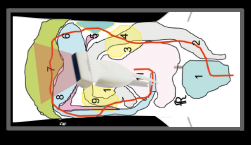






Sasha, FI, 2 months

Probe position in a different patient



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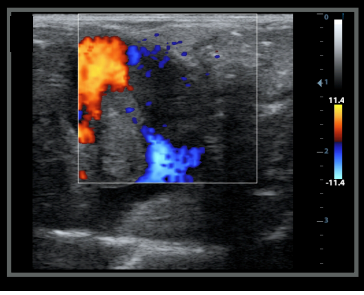
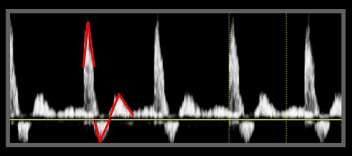


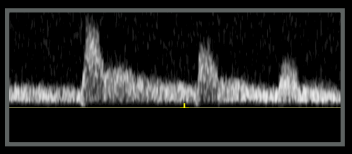
Aortic flow

High peripheral resistance



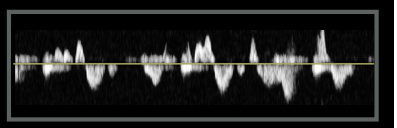
Renal artery

Reduced peripheral resistance

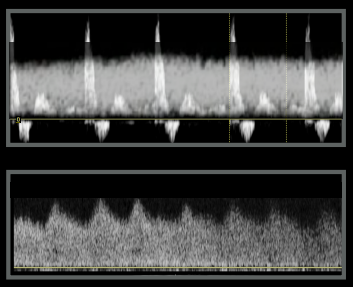


Portal flow

Caudal Vena Cava flow

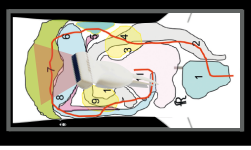


Artero-venous malformation



Sasha, FI, 2 months

Probe position in a different patier



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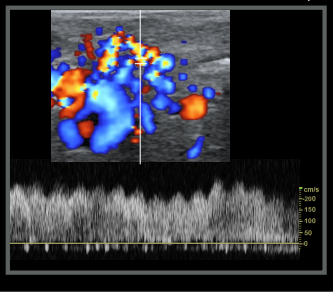
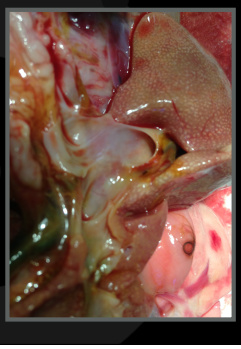


Sasha, DSH, FI, 2 months

Ultrasonographic diagnoses

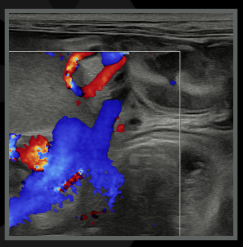
- Artero-portal malformation
- Suspected portal vein thrombosis
- Owner declined treatment

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