Professor Dr. med. habil. Thomas Scholbach
Functional Sonographic Diagnostics
Sonographic Perfusion Measurement
www.scholbach.de

Address Rödelstr. 24
D - 04229 Leipzig
Phone +49 341 688 0219
E-mail info.scholbach@posteo.de

Medical history

Preoperative history

The patient's current medical history lasts for 5 years and began with pain in the epigastric region, symmetrically distributed to both hypochondria. Initially, the patient vomited but this subsided meanwhile. A diarrhoea with 3 daily episodes persisted, nevertheless. Both, pain, and disturbed transport of food resulted in a weight loss of 22 kg at maximum. The actual weight of the patient is 57.8 kg at in height of 160 cm. Her minimum weight was 43 kg and her maximum weight 65 kg.
The pain in the epigastric angle is a persistent one throughout the whole day at a level of 7/10 but increases one hour after a meal to 10/10. Nausea is constant and severe. Then, the patient describes an aching and shooting pain from the epigastric area to the lumbar spine on the back at the same level. When the pain is severe, the heart is felt pumping in the epigastric angle. The legs do swell sometimes, the feet are bluish and purple, the patient reports about a severe shortness of breath with an inability to inhale properly. This is described as the feeling of suffocating. In deep inspiration the diaphragma is felt fluttering which increases the pain substantially.
The patient was thoroughly diagnosed by gastroscopy, colonoscopy, MRI of the abdomen and by many medical specialists from a variety of fields. No explanation was found. The only abnormality is the existence of 2 uteri and 2 cervixes. Nevertheless, the patient delivered to healthy babies, her 12-year-old daughter is suffering from very similar complaints.
Headaches are described as emerging in the nope of the neck and then radiating across the entire skull in a migraine-like fashion. The vision is then blurred, the general numbness of both feet and hands is increased. Moreover, gripping things tightly produces a numbness of the fingers.
Recently , micturation became painful and urgent but only when the patient is in an upright position. Because of the pain in the epigastric area her breast implants had been removed at no avail.
Menstruation is very painful and strong.
The patient cannot work anymore after a car accident and due to these complaints. The medical treatment was ineffective so far.

Preoperative clinical findings

The patient shows distinct signs of hyperflexible joints since she can easily press her thumb to the ipsilateral forearm. Other signs from the Beighton score are nevertheless negative.
The auscultation of the abdomen reveals a clearly audible systolic murmur which is pronounced during expiration and best detected in the epigastric angle, exactly at the region of the patient's maximum pain. Another painful region is somewhat more caudally, within the midline of the abdomen, about 4 cm cranially to the umbilicus. Moreover, the left suprainguinal region is also painful. The peristalsis sounds normally. The pulsation of the aorta is readily felt immediately below the abdominal wall in the mid abdomen. Both kidney areas are not sensitive to touch. The subcutaneous tissue is remarkably flaccid and distensible with striae distensae around the umbilicus. No pathologic lump can be palpated. The cutaneous vasculature is unremarkable.

Postperative history

The patient was operated by Professor Sandmann three weeks ago to correct a severe median arcuate ligament syndrome and a May -Thurner constellation. The coexisting complete compression of the left renal vein has been left untouched and a nephropexy of the right kidney has been performed. After the operation, the patient is "happy with the results". She now can breathe much better, the swelling and bluish discoloration of both legs completely disappeared, nausea is much reduced and the epigastric

pain in general is reduced by more than 50% with respect to the time of appearance and by a 30% with respect to its severity. The patient describes now that she feels still a certain pressure inside the epigastric region and pain sensations for 10 hours at the level of 7/10 compared to preoperative symptoms reaching 10/10 for 24 hours 7 days a week. The sensation of nearly suffocating completely disappeared. The patient can now breathe deeper but still feels some pressure while breathing deeply. The fluttering of the diaphragma is substantially reduced. There is still a pain in the right flank. Now an aching of the entire right arm is felt without a disturbed motor or sensory function.
The actual weight is 55.5 kg. No diarrhoea or vomiting is reported. The today's examination is to control the results of the operation.

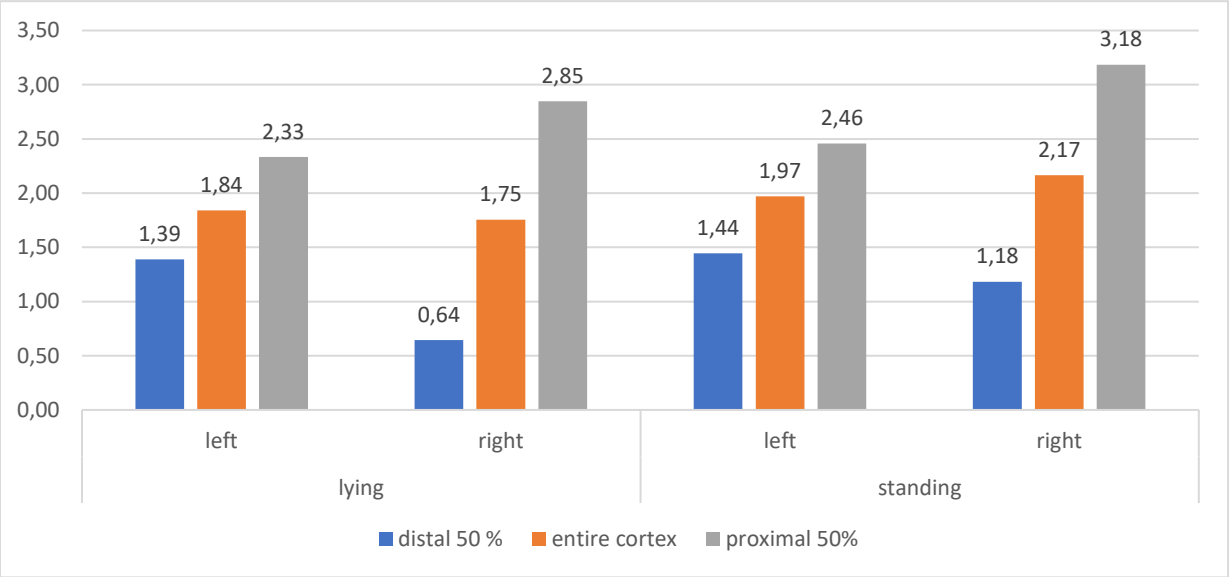
Postperative clinical findings

The abdominal palpation is producing some pain in the right renal fossa but nowhere else in the entire abdomen. During auscultation no vascular bruits are audible and a normal peristalsis can be found. The scar in the mid abdomen reaching from the xiphoid towards the symphysis is not distended and unremarkable. A pathologic lump is not palpable. The preoperative systolic murmur completely disappeared.

Postperative sonographic findings

Within the aorta while lying supine a maximum flow velocity of 125 cm/s is found. The origin of the coeliac trunk now shows no compression anymore and no movement throughout deep in- and expiration. At the origin of the coeliac trunk the flow velocity is found at 226 cm/s in midposition of the diaphragma, 192 cm/s in inspiration and 192 cm in expiration. This gives evidence of a complete decompression of the coeliac trunk and thus an excellent surgical outcome.
The blood flow velocity within the origin of the superior mesenteric artery is undisturbed with a normal flow pattern at maximum flow velocities at 156 cm/s.
The left renal vein, left untouched during the operation , has a completely obstructed right sided segment and drains the entire blood via paravertebral collaterals. The blood flow velocity within its left-sided segment is 10 cm/s.
Today a continuous antegrade blood flow within the left internal iliac vein can be described which transports a flow volume of 326 mL/min cephalad. This is in strong contrast to the preoperative finding where a reversed flow with a volume of 118 mL/min was found.
Within the 2 right internal iliac veins a blood flow volume is found which adds to 300 mL/min. Thus, the pelvic circulation recovered substantially after the decompression of the left common iliac vein.
The formerly compressed segment of the left common iliac vein is now protected by an external PTFE shield thus allowing a constant lumen of the left common iliac vein of 10 mm sagittally. The blood flow runs undisturbed through the now decompressed vein. At the preoperative compression site, the flow velocity now is found at 34 cm/s compared to 159 cm/s preoperatively.
Both kidneys have a normal appearance and normal volumes: Left 70 , right 56 mL/m².
The kidney position is checked during a prone and an erect posture of the patient. After standing upright the left kidney moves caudally by 5 cm, the right kidney by 2.8 cm only. The right kidney has been fixed. Its preoperative movement was about 8 cm!
The decompression of the collateral pathway via the left common iliac vein plus the nephropexy on the right side improved substantially the renal perfusion on both kidneys in lying and standing posture. Now the left kidney shows no reduction of blood flow compared to the right one whereas preoperatively its perfusion was reduced by about 50% compared to the right one. While standing the former excessive drop of left renal perfusion is now completely resolved. No perfusion drop at all can be stated in the left kidney whereas the right kidney also improved a lot after the nephropexy. Its flow volume more than doubled compared to the preoperative finding. This substantially alleviates the necessity of the pelvic circulation to transport additional blood while standing. This contributes to the excellent clinical and sonographic outcome of the decompression interventions.

Diagram of the renal parenchymal perfusion measurement with the PixelFlux technique
The columns indicate the perfusion intensity in cm/s calculated as perfusion velocity [cm/s] of all colored pixels multiplied by the area of all colored pixels [cm²] divided by the area of all pixels of the entire region of interest [cm²]


3,50
3,00
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1,39
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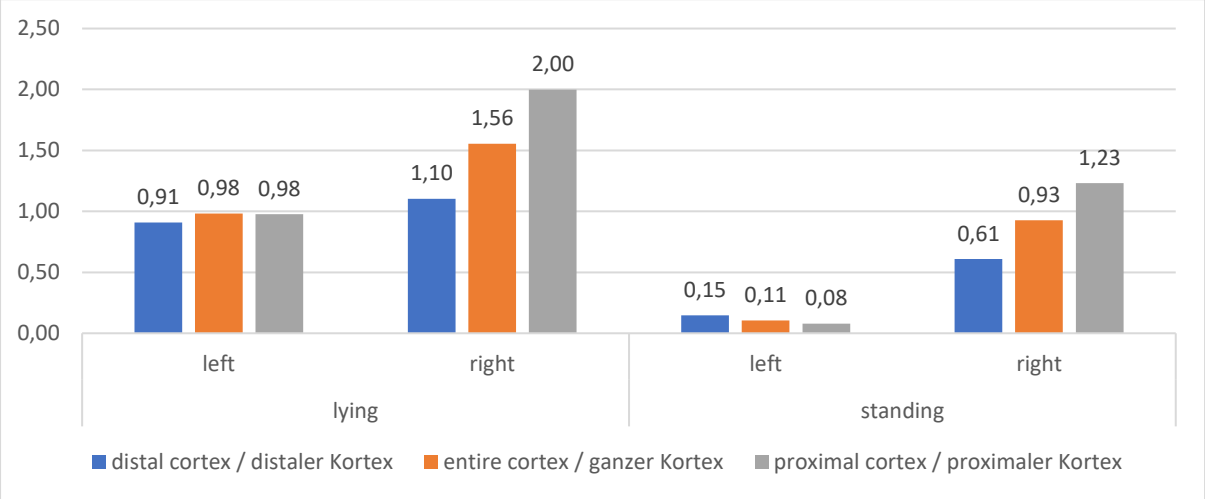
1,75
2,85
1,44
1,97
2,46
1,18
2,17
3,18
left
right
left
right
lying
standing
distal 50 %
entire cortex
proximal 50%

Preoperative measurements:



Diagnoses

1. Excellent decompression of the coeliac trunk
2. Complete restoration of the perfusion of the left kidney while being supine
3. Restoration of the renal perfusion of the left side while standing with an increasing blood flow **20 times higher than preoperatively** !
4. Restoration of the right renal perfusion while being upright with a doubling of the perfusion volume
5. Persistent complete interruption of the left renal vein at the crossing with the aorta

Recommendations

If any symptoms should arrive which might be interpreted as a sign of a recurrence of compressions, may be by scarring, I recommend a repeat- scan to compare the results with the post-operative ones.

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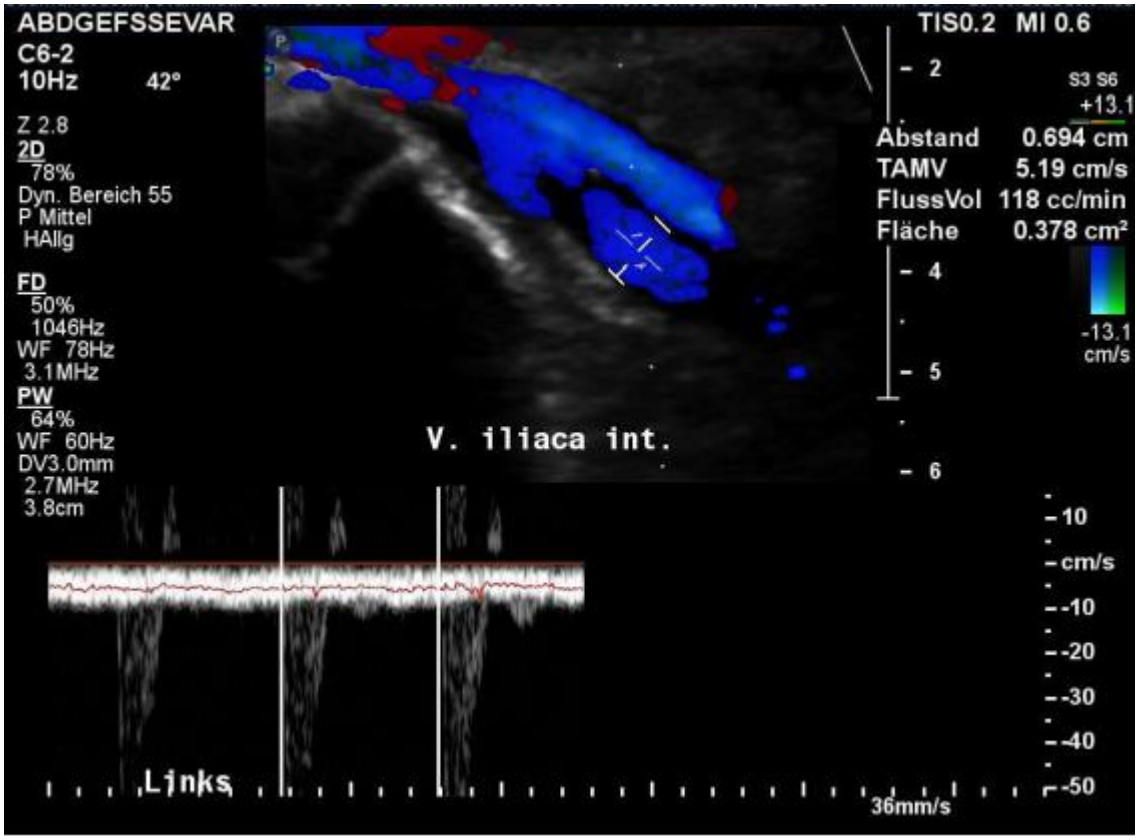
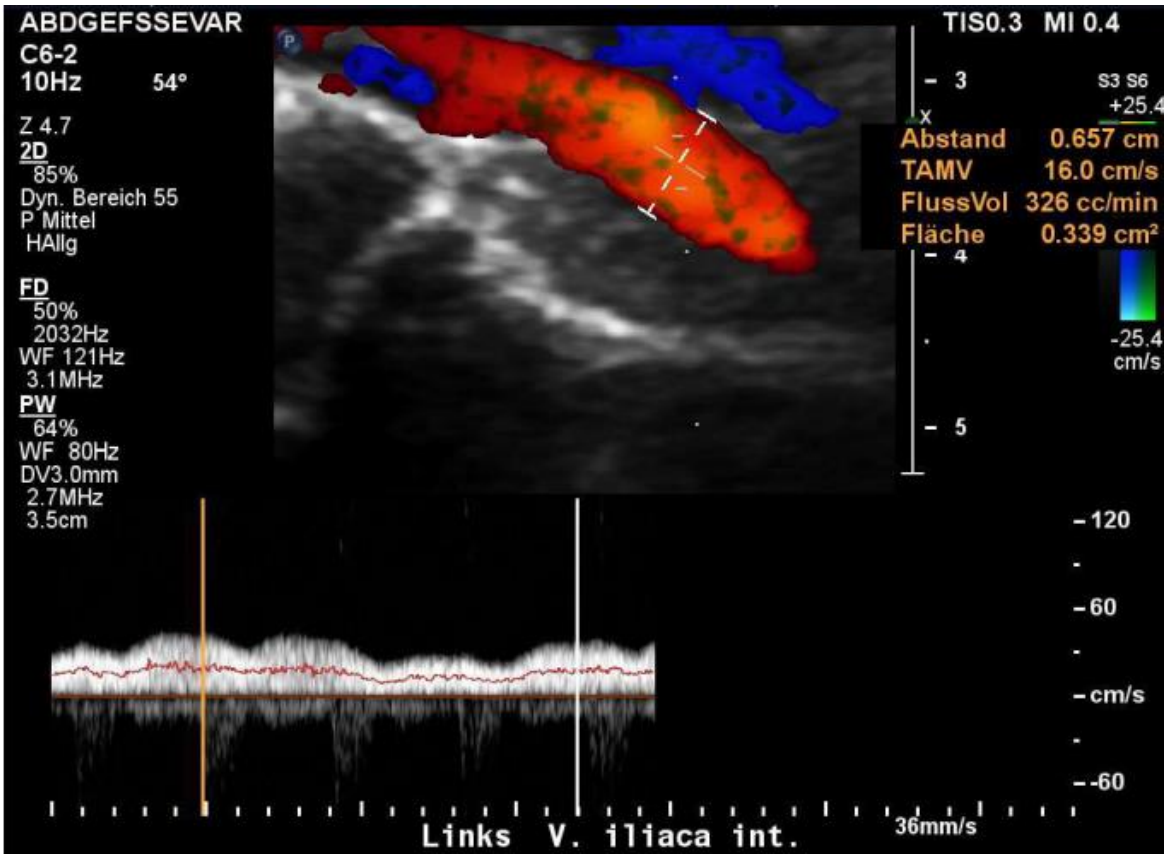
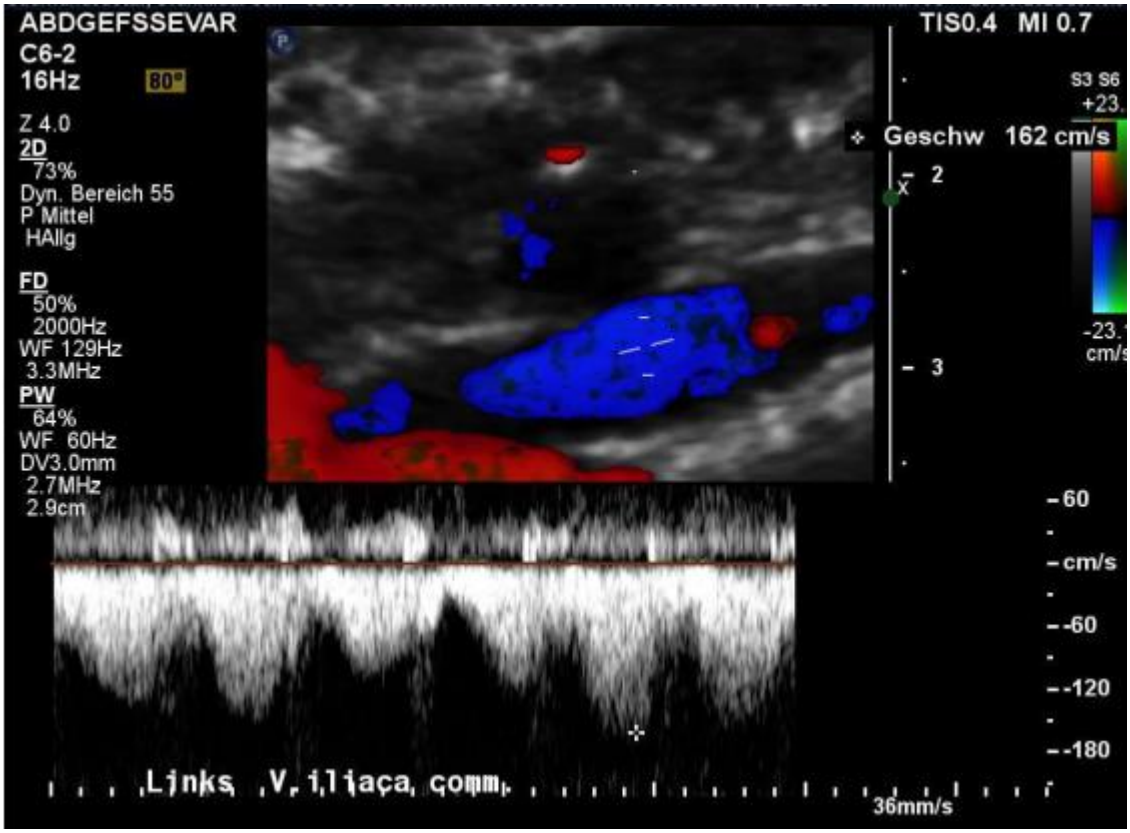
Illustrative pre-/ postoperative images



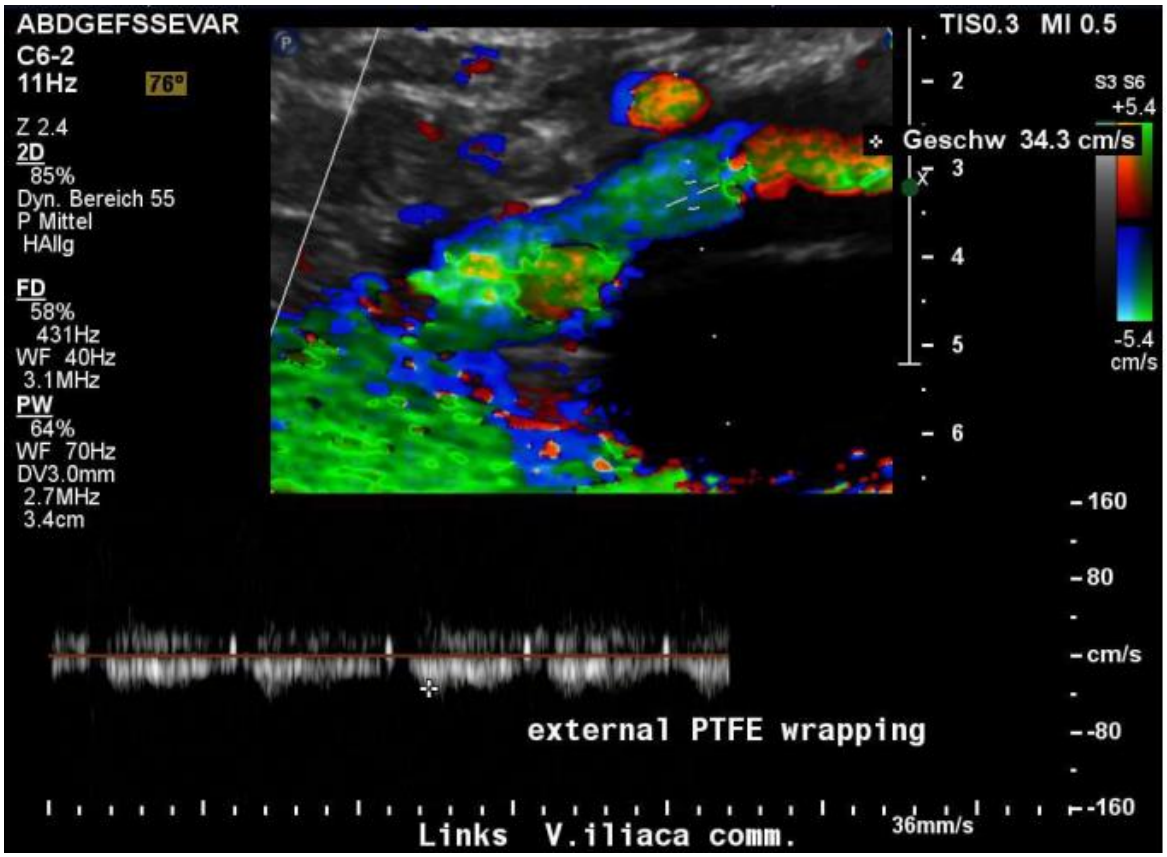
Preoperative: severe May-Thurner-s. produces flow reversal in the left internal iliac vein: -118 ml/min



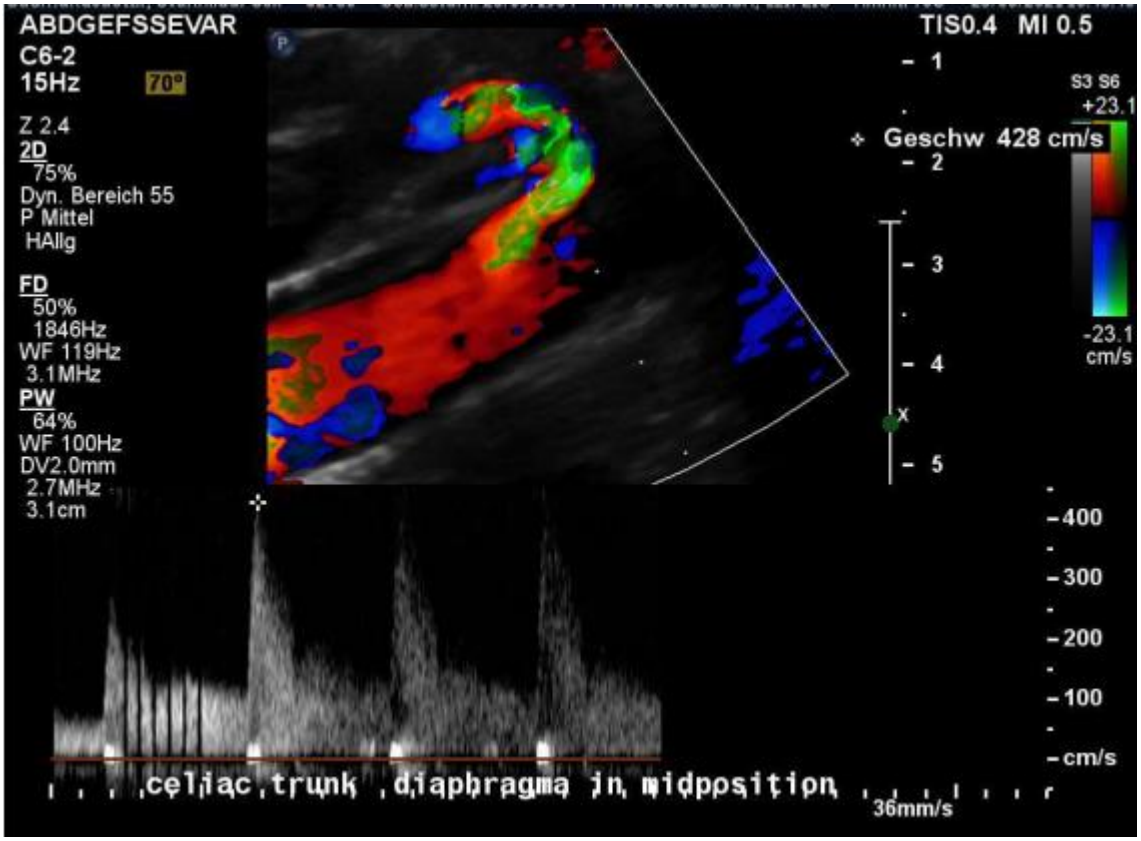
Postoperative normalization of the flow direction and volume in the left internal iliac vein



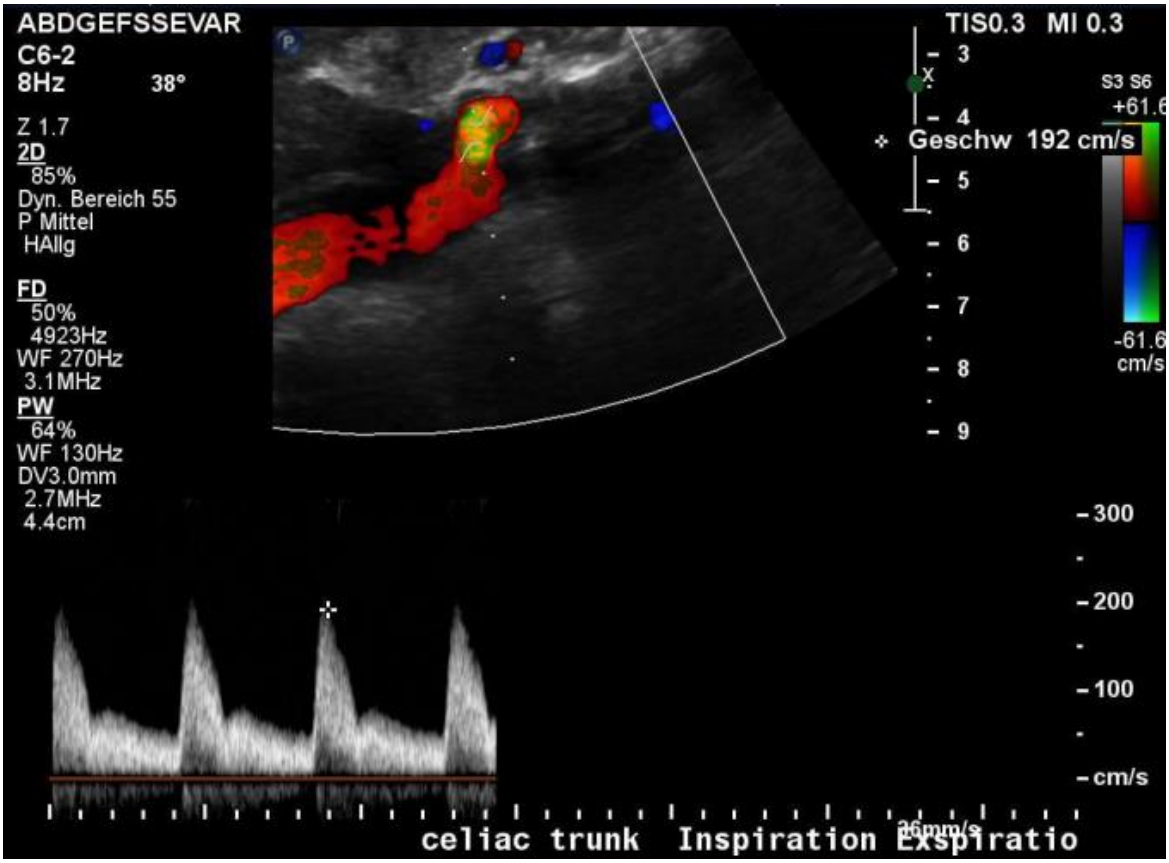
preoperative: strong pulsatile flow acceleration at the May-Thurner-point



postoperative: no more flow acceleration at the May-Thurner-point after external PTFE-wrapping



preoperative: massive celiac trunk dislocation and compression by the median arcuate ligament



postperative: even in expiration no celiac trunk dislocation and compression

extreme lumbar lordosis lifting the spine towards the abdominal wall – only 6 mm distance remains