The RUSH-Protocol

Rapid Ultrasound in Shock and Hypotension

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Introduction and Objectives

Shocked patients are one of the biggest challenges in the emergency medicine. Often you cannot identify the underlying problem with conventional instruments. In 2006 Weingard SD et al published the so called RUSH-Concept for the first time. This concept is aiming to get a working diagnose, via a focused ultrasound examination, in a few minutes.

The RUSH-Concept limits the causes which makes the assessment of a hypoton, shocked patient possible.

We want to point out, that this concept has been developed for emergencies. For this purpose, we teach to perform it with a sector probe and in echocardiographic orientation.

Components

The RUSH-Concept can be split up in 3 main components

PUMP	TANK	PIPES
In this part 4 sections of the heart are made, to look for cardial reasons	While meassuring the vena cava inferior as well as looking for free fluid (efast) you can draw conclusions to the volume status of the patient.	Looking for a possible rupture of an aortal aneurysma in the aorta thoracica or abdominalis.

Pump

There are 4 sections you should evaluate with a sector probe

1. Parasternal long axis
2. Parasternal short axis
3. Apical 4-chamber-view
4. Subxiphoidal view (part of the eFAST)

Parasternal long axis

Probe position:
Left parasternal in the 3rd or 4th ICS, marker of the probe should point towards the patient's right shoulder.

In this position you can see the left and the right ventricle, the left atrium with the mitral valve and additionally the left ventricular effusion tract with the aortal valve. Furthermore, next to the left atrium the aorta descendens and the hyperechogen pericard can be seen.
Attention should be paid to the right ventricle, which is represented on the top of the ultrasonic scan, while the left ventricle is further down.
In this scan you can evaluate the left ventricular pump function and a possible pericardial effusion. Furthermore, a dilatation of the right ventricle, as an indication for a right heart strain (e.g. pulmonary embolism) or wall motion disorders (e.g. ischaemia) can be detected.

Evaluation of the left ventricular pump function
It is not constructive to perform exact measurements in case of emergency. Usually the so called „eyeballing" is enough to get a working diagnosis as soon as possible. What counts is the performance rating whether the left ventricle is pumping poor, normal or excessive.

Periacardial effusion vs. Pleural effusion
A periacardial effusion would present itself as an anechoic frame around the heart. To delineate it from a pleural effusion you should examine the aorta descendens. In a pleural effusion there would be fluid between the aorta descendens and the left atrium.

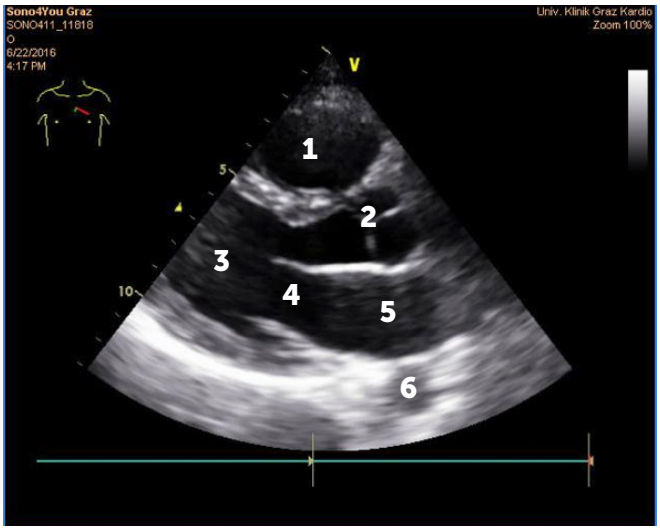


Fig.1: Parasternal long axis.
1: Right ventricle, 2: Aortic valve, 3: Left ventricle,
4: Mitral valve, 5: Left atrium, 6: Aorta descendens

Parasternal short axis

Probe position:
First try to get the parasternal long axis and then turn the probe 90 degrees clockwise, the marker on the probe should be in line with the left shoulder of the patient.

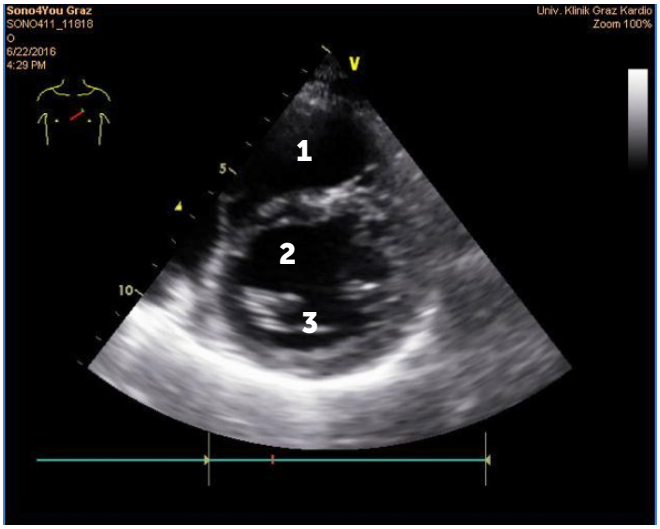
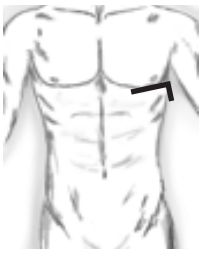


Fig.2: Parasternal short axis.
1: Right ventricle, 2: Left ventricle, 3: Mitral valve

Representation of the right and left ventricle in the cross-section.
Equal to the long axis you can also evaluate the left ventricular pump function via M-mode in the parasternal short axis. Additionally, you can identify a pericardal effusion, a ventricular dilatation or a wall movement disorder.

Depending on different sources, this section can be looked at additionally , but it is not a compulsory part of the concept.

Apical 4-chamber view



Probe position:
Beneath the left breast (at level with the apex beat), marker straight to the left.

In this section you look from the apex of the heart to the base, you can see all 4 chambers as well as the tricuspidal valve and the mitral valve

In this view, it is possible to estimate ventricular function and size and to judge the function of the mitral and tricuspidal valve. Pericardial effusion or a papillary muscle rupture would also be visible.

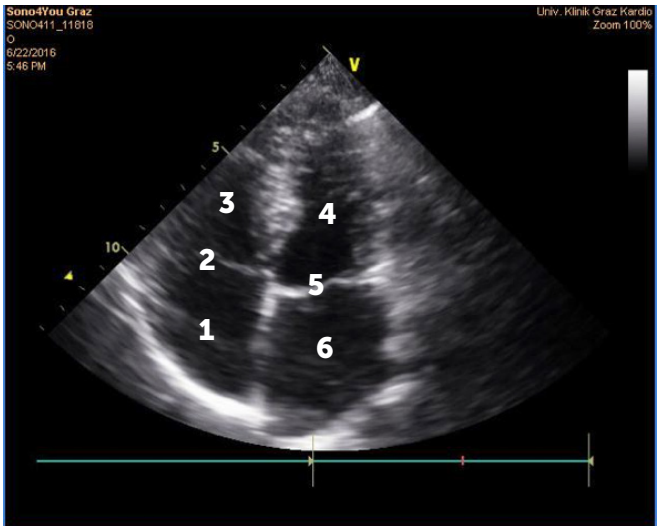


Fig.3: Apical 4-chamber view.
1: Right ventricle, 2: Tricuspidal valve, 3: Right atrium, 4: Left ventricle, 5: Mitral valve, 6: Left atrium

Subxiphoidal view

Probe position:
Transversal beneath the xiphoid, marker to the left.

In this section we look at the heart from caudal. We use the liver as an acoustic window.
Near the probe, there is the right ventricle and the right atrium, whereas further away from the probe you can see the left atrium and ventricle.

Because of the good overview of the heart, the evaluation of the pump function, the valve function and the scan for free fluid in the pericard is possible. This is the reason why this section is also a part of the e-fast exam.

Pericardial effusion vs. pericardial tamponade
As an indicator for the severity of an effusion you can consult the compression through the circumferential fluid of the right ventricle.
If the diastolic filling condition of the right ventricle is normal, the effusion can not be the primary problem (e.g. in case of a chronical effusion).
However, if the right ventricle is dented in the diastole, you can assume that the reason for that is a beginning pericardial tamponade.
Another indication is a hyper dynamic right atrium, which is powerfully trying to press blood into the constricted ventricle.
This phenomenon is called „furious right atrium".

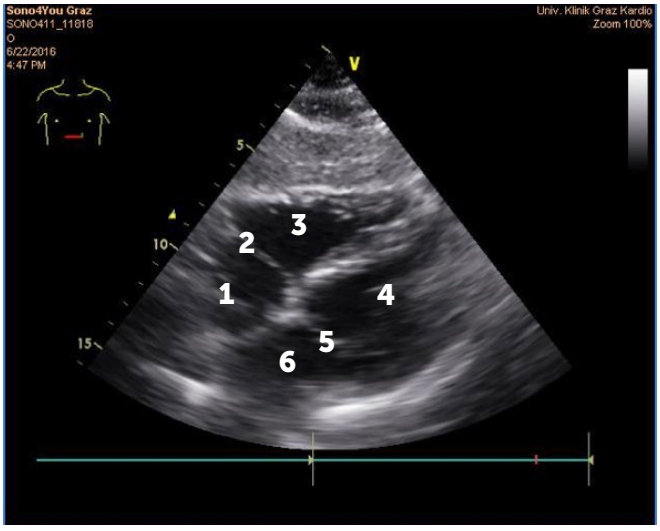


Fig.4: Subxyphoidal view.
1: Right ventricle, 2: Right atrium, 3: Tricuspidal valve, 4: Left ventricle, 5: Mitral valve, 6: Left atrium

Tank

Included in this part is on the one hand a longitudinal section of the vena cava inferior and on the other hand the whole eFAST examination, for scanning the abdomen and thorax for free fluid and to exclude a pneumothorax.

For further information and explanation of eFAST there is another script available.

Vena cava inferior

Probe position:
Longitudinal cut right below the xiphoid, marker caudal.

You can see the vena cava inferior with the confluence in the right atrium and the liver.

Measuring the size of the diameter has to be carried out via m-mode, cranial of the confluence from the liver veins during the inspiration and expiration.

If the diameter of the vena cava is < 1,5 cm , a reduction of the central venous pressure can be assumed, e.g. by reason of hypovolaemia. This patient would benefit from a volume resusitation.

If the diameter is > 2,1cm with an inspirational collapse <50%, an increased central venous pressure (>10-20mmHg) can be assumed.
e.g. as a result of a cardiogenic shock or a pericardial tamponade.5
A specific tidal volume by ventilated patients has to be applied.

You have to pay attention to the physiological pressure conditions, since they are vice versa when you use the overpressure ventilation. Due to this the vena cava is dilated during inspiration.

Cave: The caliber of the vena cava can have considerable individual deviations.
There are also factors like intrabdominal pressure, the ANP-concentration, vasodilators or a possible insufficiency of the heart, which can influence the diameter. This means that the evaluation is not suitable for a snap-shot of the vena cava, however, the fluid tolerance of a patient in an extending control can be significant.

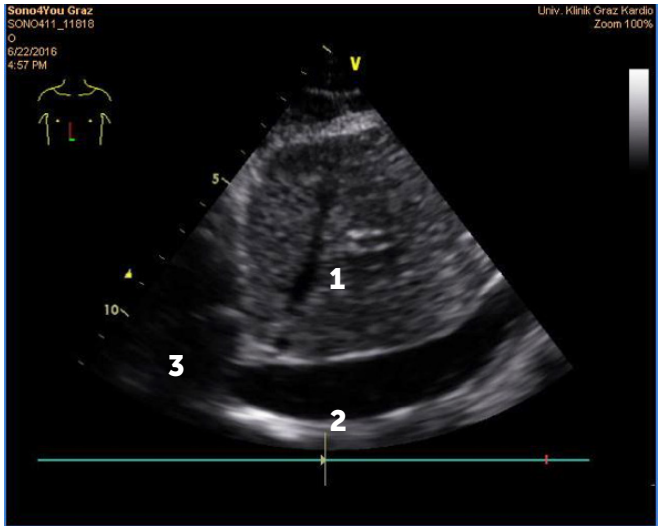


Fig.5: Longitudinal view of the Vena cava inferior.
1: Liver, 2: Vena cava inferior, 3: Right atrium

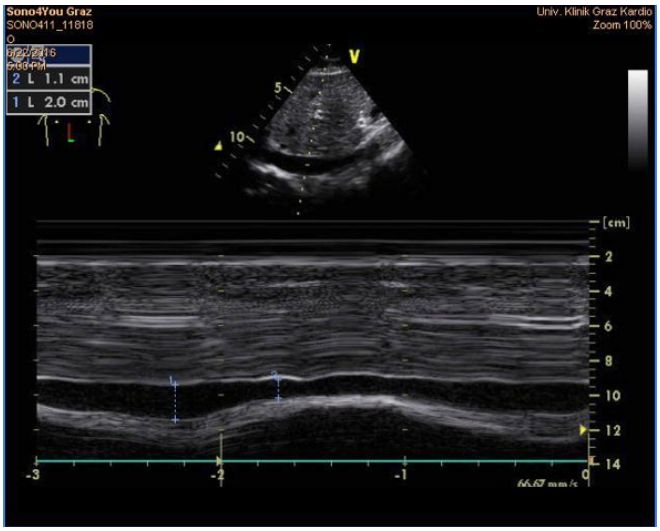


Fig.6: M-Mode of the Vena cava inferior

Pipes

Aorta thoracalis
Probe position:
Aortic root: please refer to the parasternal long axis
Aortic arch: suprasternal, marker straight to the left

In the parasternal long axis, the cross-section of the aortic root can be measured (Norm: < 3,5 cm). Then the aortic arch can be shown by means of a suprasternal cross-section.

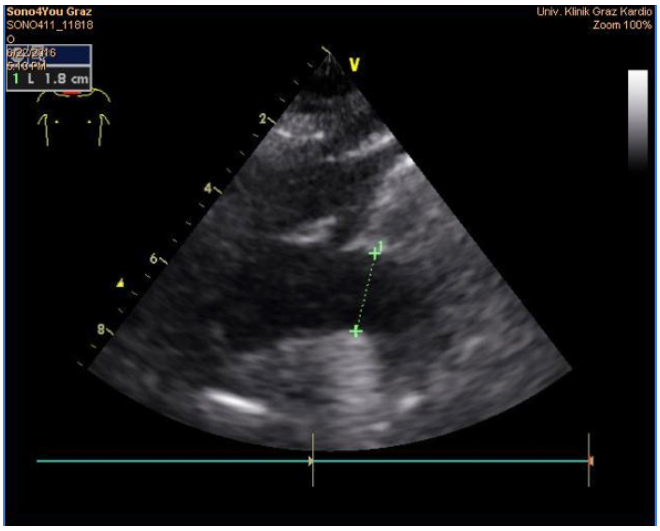


Fig.7: Suprasternal view of the Aorta thoracalis

Aorta abdominalis
Probe position:
Cross-section subxiphoidal, Marker straight to the left.

In this section you try to follow the vessel from subxiphoidal to the aotic bifurcation (height of the navel) in the cross-section. If there are any dilatations, they should be measured.

Cave: You can often detect thrombus formation along the vessel wall. In this case, it is important to measure from wall to wall.

In case of a dissection, a loose initima can perhaps be seen. A distinction of the lumina is possible.

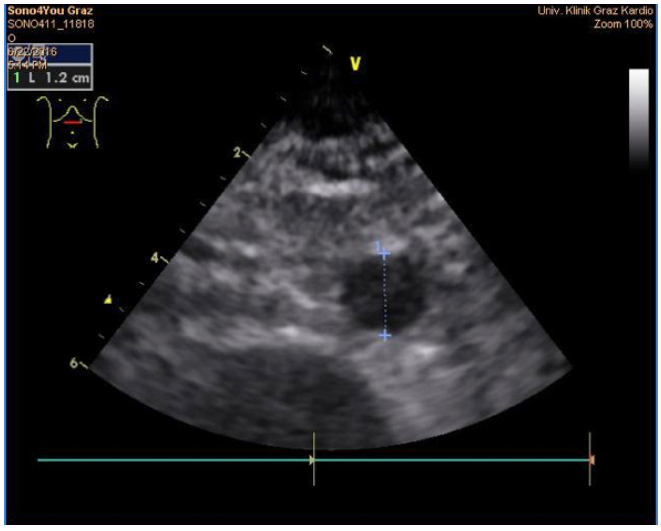


Fig.8: Cross section of the Aorta abdominalis

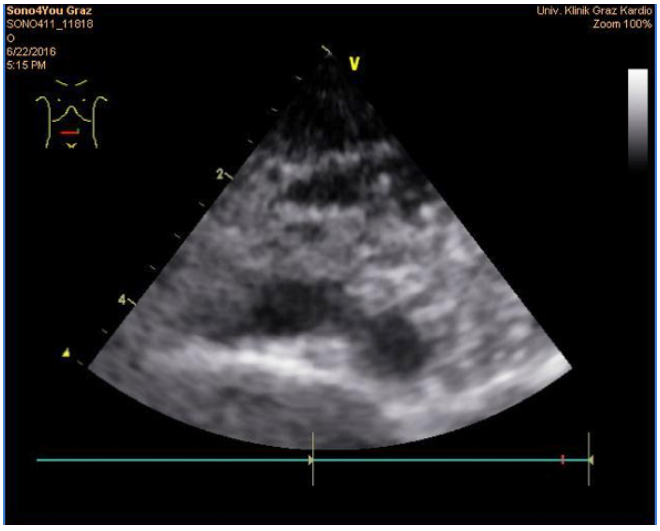


Fig.9: Cross section of the aortic bifurcation

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