Let's Dot it. How to Program a Dot Examination of the Liver

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1 First Dot training.

Introduction

The Institute for Diagnostic and Interventional Radiology and Neuroradiology headed by Univ. Prof. Dr. med. M. Forsting at the University Hospital Essen is one of the largest radiology departments in Germany. We work with six MR systems in our institute. These include a 1.5T MAGNETOM Avanto, two 1.5T MAGNETOM Aera systems, one 3T MAGNETOM Skyra, one Biograph mMR and one 7 Tesla system*, all from Siemens. Our department was one of the first clinical users of Dot§ (day optimizing throughput) engines worldwide. After we had applied our basic knowledge in clinical operation, advanced training in Dot was held at our institute by Dipl. Ing. Karl-Heinz Trümmler (an MRI application specialist from Siemens Healthcare). We enjoyed familiarizing ourselves with this software so much that, at the end, we even held a little competition to see who can

program best with Dot. If you take a close look at Dot you'll notice that this software is easy to program and will simplify your working life extremely. The following article should give you a better idea of how Dot works and encourage you to create your own examination programs tailored to your wishes.

A brief insight into Dot

Using Dot, it is possible to optimize examination workflows and shorten examination times, e.g. through automated procedures. An automatic adaptation to the patient and his or her possibilities occurs. The system e.g. adapts the Dot protocol in the area of abdominal measurements to the patient's breath-holding capability while maintaining constant image quality. Furthermore, the field-of-view (FOV), number of slices and slice thickness also are

adapted automatically, thus reducing the acquisition time and increasing the efficiency of the examination. With Dot, the user is guided through the examination and made aware of important decision points. Even inexperienced Radiographers are thus able to perform more complex examinations without assistance.

Dot navigates the user through various examinations step-by-step while displaying helpful and practical hints and sample images during each sequence. Sequences can easily be added or removed via integrated decision points at the push of a button. Dot can easily be adapted to our standards with respect to examination routines, exposures and protocols.

Following registration, the patient data and positioning information appear in the Dot display on the scanner and are used to accelerate patient positioning and preparation, since the most important points are already visible on the scanner display in the examination room.

Dot ensures optimal timing between breathing and scanning via automatic breath-hold commands. The auto bolus detection ensures that the exposure will be taken at the correct point-of-time during contrast medium examinations. A new Dot engine can be created with an amazingly small number of mouse clicks. Dot constitutes a basic framework of strategies, patient context decisions and clinically decision points. In the following, we will explain some of the most important points that are inte-

*This product is still under development and not yet commercially available. Its future availability cannot be ensured.
§ Dot is now available for 3T MAGNETOM Skyra and MAGNETOM Verio and for 1.5T MAGNETOM Aera and MAGNETOM Avanto.

grated in a Dot engine.

Dot engine step: Each Dot engine begins with the Dot engine step. This specifies the kind of Dot involved and contains the exam-related configurations depending on the patient view. Additional functions open along with the different patient views, depending on the body region involved. There is a special patient view for each type of examination. These include Neuro, Onco (Abdomen), Cardio and Angio. During this first step, the entire framework is filled with strategies, patient context decisions and clinical decision
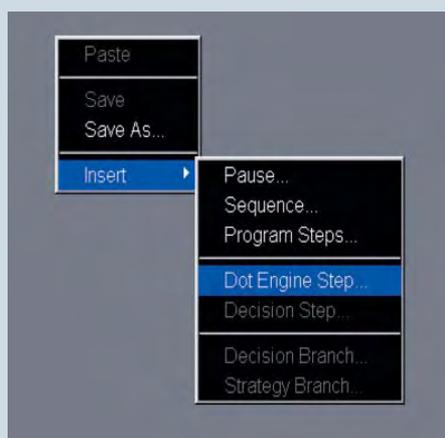
points.

Strategy: The strategies employed include the varying tactics required for different patients due to wide variations among the patient population, and may sometimes result in different sequences. This enables us to store the right sequences for each patient under a single Dot engine. Thus for example, a standard protocol can be saved for normal patients and a protocol with correspondingly faster sequences can be stored for restless patients and started during the examination. The user can coordinate the strategies to suit his or her own needs.

Strategy branch: The strategies previously defined when creating the Dot engine step are listed here. The appropriate strategy is selected while registering the patient and the corresponding sequences then open automatically. The

sequences that are suitable for the strategy are already selected and saved while creating the Dot engine.
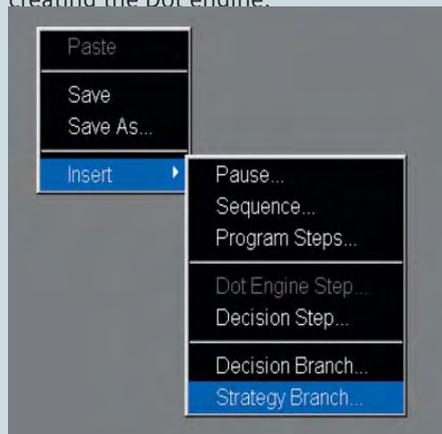

Patient context decision: Patient context decisions involve decisions that already have been made at the beginning of an examination. Like the desired strategy, they also can be selected after registering the patient and changed again during the course of the examination. The patient context decision is integrated in the examination in the form of a decision branch that enables branching of the protocol in two opposite directions. The user can decide for or against a specific patient context decision, e.g. contrast medium. All subsequently desired procedures then open linked to this patient context decision. In contrast to the decision step, a patient context decision is already made in the patient view at the beginning of the examination and does not require any decisions during the further course of the examination.

Clinical decision point: Decisions related to the clinic are initially made during the course of the examination and, as their name implies, are dependent on the patient's clinic. Sequences that are additionally required for clinical reasons are integrated in the examination procedure in the form of a decision step. The sequences desired can be added to the standard examination while it is in progress by selecting a previously defined decision step. The sequences that are run during the corresponding decision are stored in the deci-

sion branch.

Decision step: A decision that remains to be made can be selected during the course of the examination. This automatically creates a decision branch under which the corresponding sequence can be found. The sequences are saved in advance here, too, so that they will become available immediately following a corresponding decision. A decision step is required during a Dot engine run only in cases concerning a clinical decision that is initially made
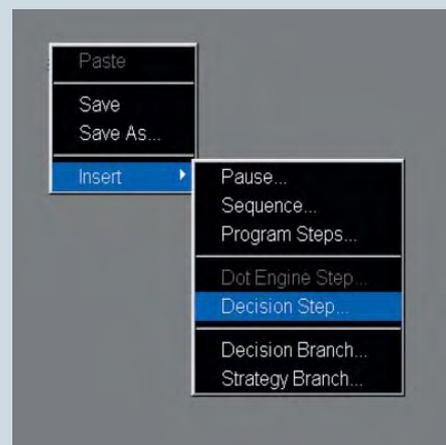
while the examination is in progress.

Decision branch: This involves branching of the examination procedure due to a patient context decision or a clinical decision. The user can decide in favor of or against a procedure. Once a decision has been made, the corresponding protocols saved there are made available.
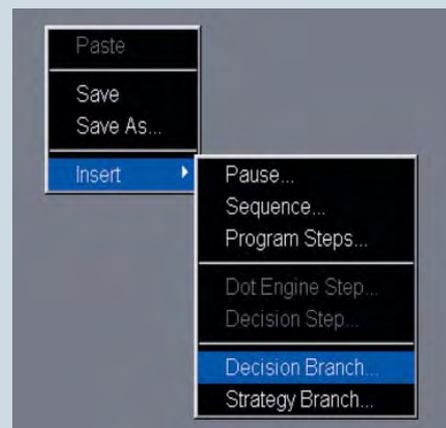
Automatic procedures / additional functions

Auto position: All Dot engines offer the possibility of automatically moving the patient into the isocenter of the respective examination region without previous centering and positioning the patient in the isocenter.

AutoAlign: This function is available only for head, knee and spine examinations and performs automatic positioning of the examination area based on previously set reference points.

AutoFOV: The field-of-view (FOV) is automatically adapted to the structure under examination. The system always selects the FOV with a tolerance range that is slightly larger than necessary to make allowances for patient-related changes, e.g. varying breath-hold phases.

AutoCoilSelect: During examinations, the coils located in the examination area are selected automatically so that the user does not have to select them manually for each sequence. This ensures that the measuring field always remains fully illuminated.

AutoBolus detection: Auto bolus detection promotes optimal timing during dynamic contrast medium examinations. The position where the signal intensity is to be measured in the vessel is determined via a region-of-interest (ROI). The sequence then starts automatically as soon as the previously selected reference value has been reached. Therefore, false starts seldom occur, which is why examinations in which the exposure is to be taken during a specific blood circulation phase (e.g. the aortic arterial phase) often show a better contrast.

AutoVoice commands: The automatic breath-hold commands improve the timing between contrast medium enrichment, the breath-hold command and the scan. A large number of languages can be programmed to simplify examinations without having to rely on an interpreter. In combination with AutoBolus detection, the length of the automatic breath-hold command also must be accounted for in the contrast medium timing.

Different patient views:
Only the Neuro patient view is available in the standard package. The patient views specify which additional functions can be accessed during the examination. It is thus for example possible to automate the dynamic 3D VIBE measurements in the liver study and add AutoBolus detection with the help of the Dot add-in ABLE.
- ABLE (abdomen breath-hold liver examination) = Abdomen with contrast medium dynamics, automatic breath-hold commands, automatic start of sequences after contrast medium detection. Delay times can be inserted variably.
- Angio bolus timing = for angiographies with breath-hold command; graphic regions, veins, arteries, automatic arterial time calculation (delay).

- AutoAlign scout = Automatic tilting according to specific reference points.
- Generic views = Guidance images and scope of parameters.
- MPR planning = Planning of multiplanar reconstruction (MPR), can be used only once per Dot engine.
- MPR assignment = Executes the plan, automatic reconstruction.
- Cardiac basic
- Cardiac marker lock = Sets axial points when planning the heart axes.
- Cardiac SAX planning = For planning short axes.
- BOLD = Blood Oxygenation Level Dependent imaging for functional measurement.

Example of application

Now we will show you how to create a Dot engine based on the example of a liver study.
It is advisable to make a sketch of the desired protocol before you start creating the Dot engine.

Leber Untersuchung

Localizer

↓

SB Haste cor → Standard BH → Trufi cor
→ Standard Pace → Haste cor trig

↓

SB Haste tra → Standard BH → Haste tra
→ Standard Pace → T2_Haste_fs_tra_trig

↓

ep2d_diff_tra

↓

SB T2 tse tra → Standard BH → T2_tse_fs_tra
→ Standard Pace → T2_Blade_fs_tra_trig

↓

T1_Flash_opp.in._tra
T2_Haste_cor_thick
T2_Haste_cor_thick
T2_Haste_cor_thick
T2_Haste_cor_thin

↓

DS MRCP dünn
↳ DB MRCP dünn → mit MRCP dünn → T2_spc_cor_ti
→ ohne MRCP dünn

↓

DB KM

↙ ohne KM   ↘ mit KM

ohne KM   mit KM
↓   ↓
T1_vibe_fs_tra_pre   T1_vibe_fs_tra_pre
                           Care Bolus
                           T1_vibe_fs_tra_arterial
                           T1_vibe_fs_tra_venoes
                           T1_vibe_fs_tra_venoes2
                           ↓
                           T1_fl2d_fs_tra
                           T1_fl2d_fs_cor
                           ↓
                           DS Vibe extra
                           ↳ DB Vibe extra
                  ↙   ↘
              ohne Vibe extra   mit Vibe extra
                                   ↓
                                   T1_vibe_fs_tra

Then the Dot engine is created as shown in this example based on a liver study.

Open the user tree.

=
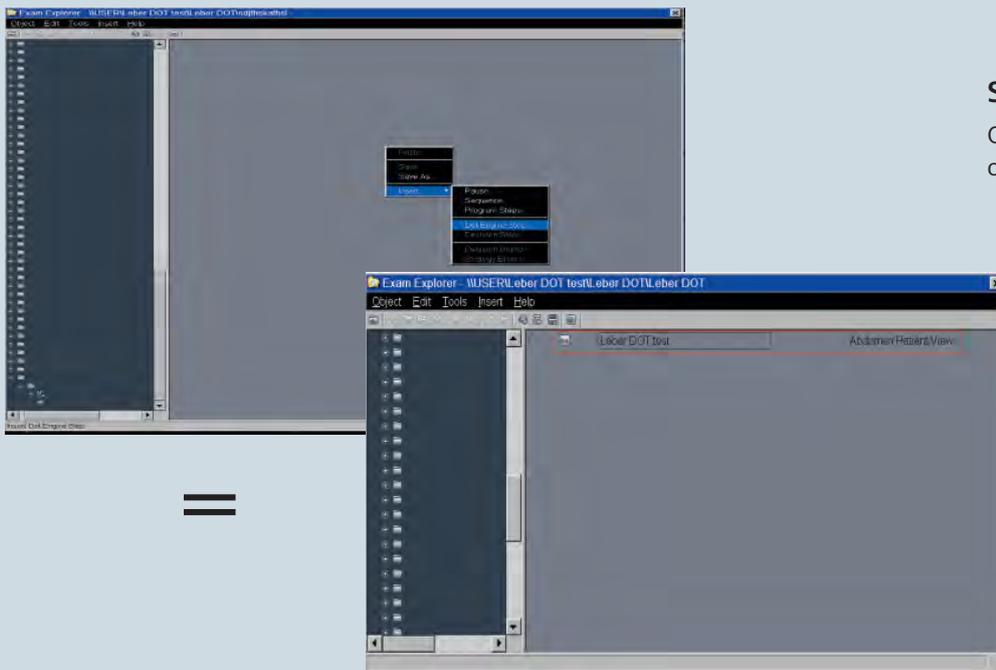
Step 1:

Open the subfolder and create a Dot engine.
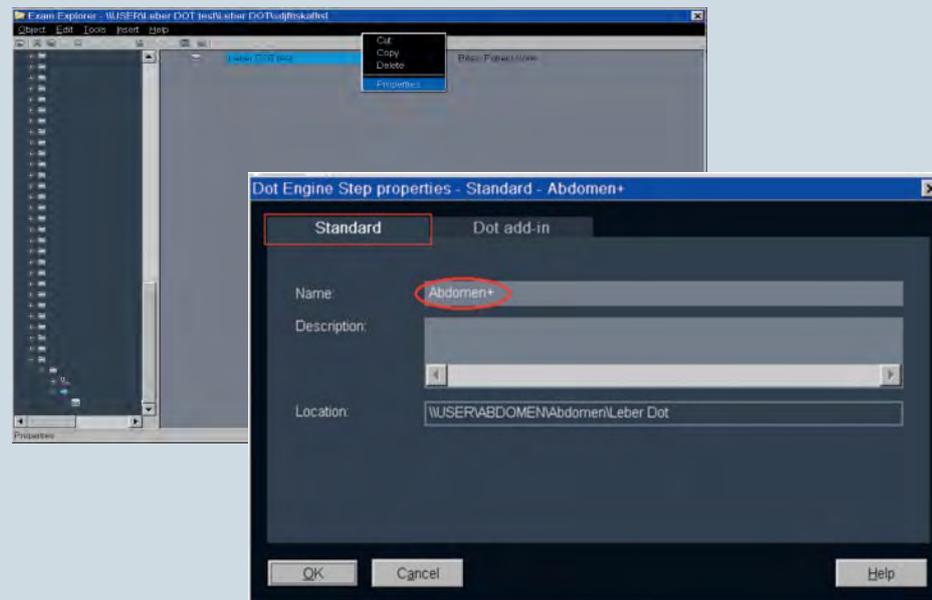
Step 2:

E.g. right-click the Dot engine and select "Properties" or double-click, open and name it.

Step 3:

Select the patient view suitable for the examination via Dot add-in.
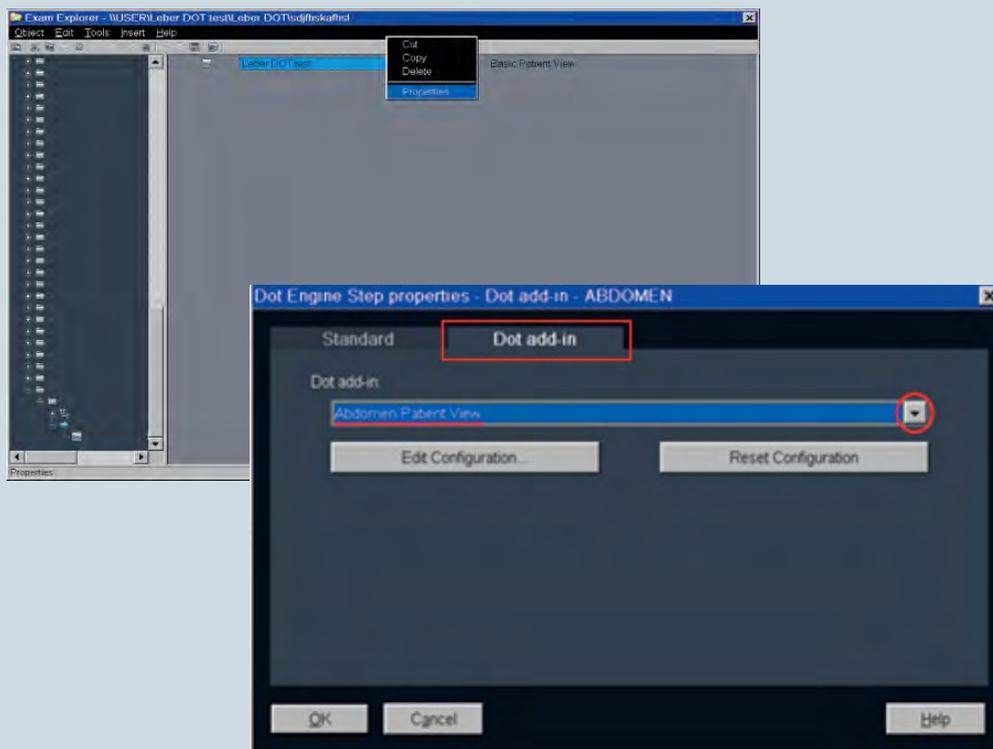
Step 4:

Select "Edit Configuration" to configure the Dot engine.
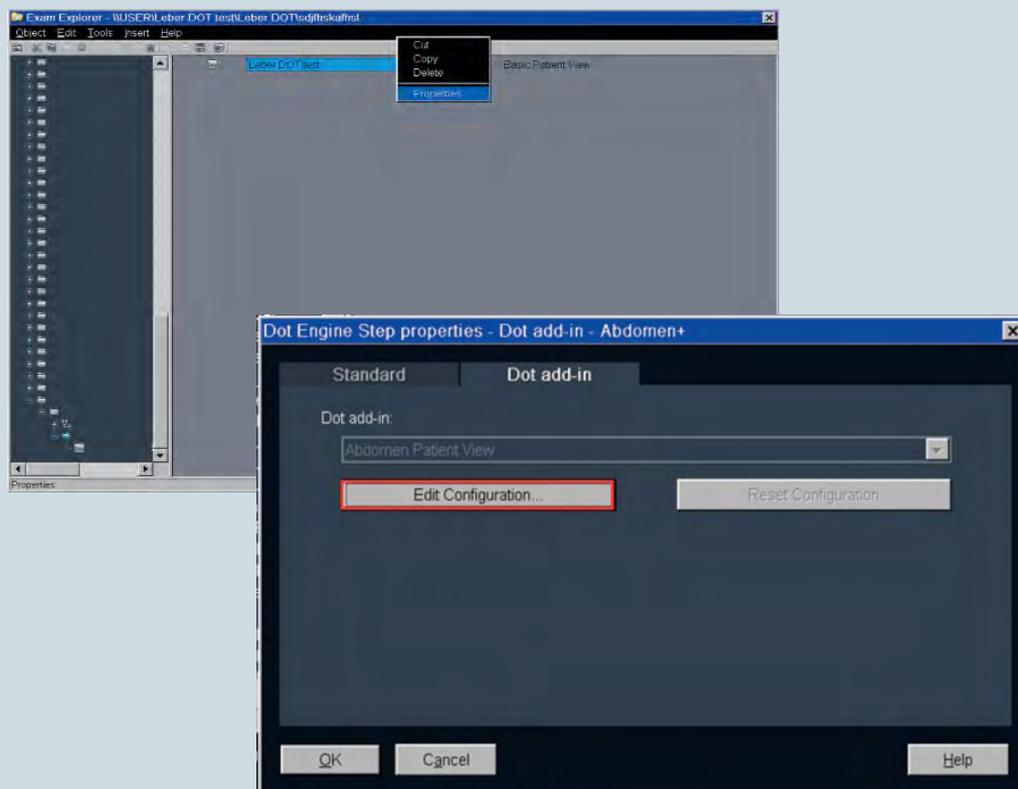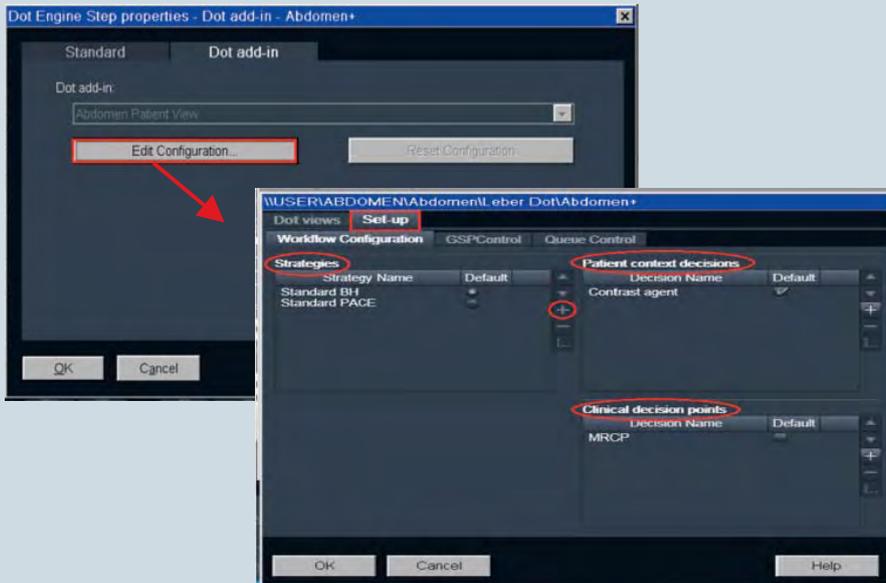
Step 5:

Define the strategies (strategy branch), patient context decisions (decision branch) and clinical decision point (decision step) for the examination by adding them.
Hint: The number of strategies can no longer be changed once the protocol has been put into operation. In order to keep this option open, you might want to insert a placeholder under "Strategies" at the beginning.
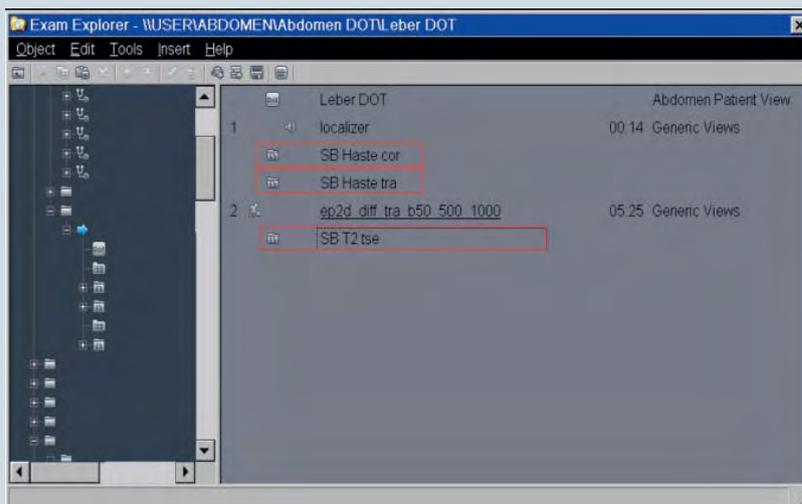
Step 6:

A strategy branch can then be integrated whenever varying sequences are to be used for different strategies. If the sequences are the same for all strategies, they can be inserted directly without generating a branch.
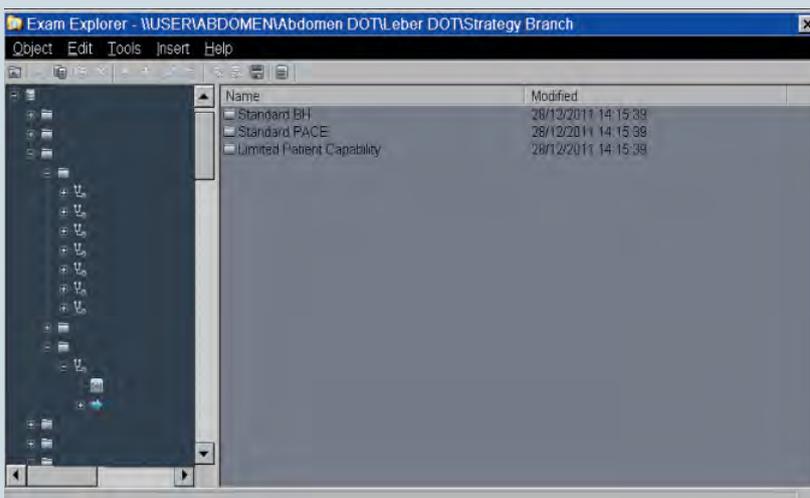
Finally, the correct sequences are saved under the individual strategies.

Step 7:

Insert a decision step to enable a decision for a thin MR colangiopankreatography (MRCP) during the course of the examination. The decision step always includes the Dot "basic decision" add-in.
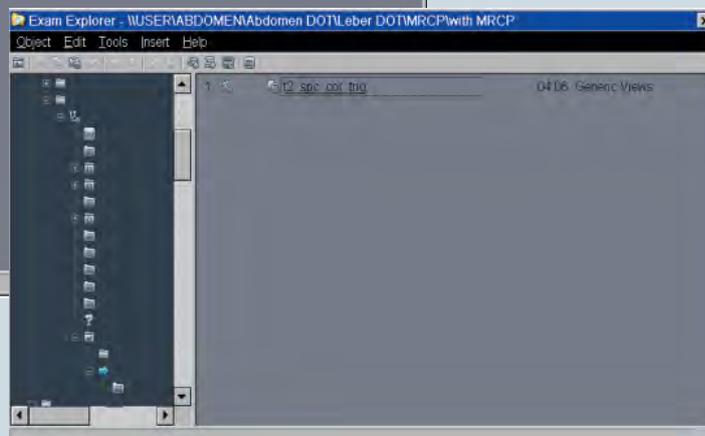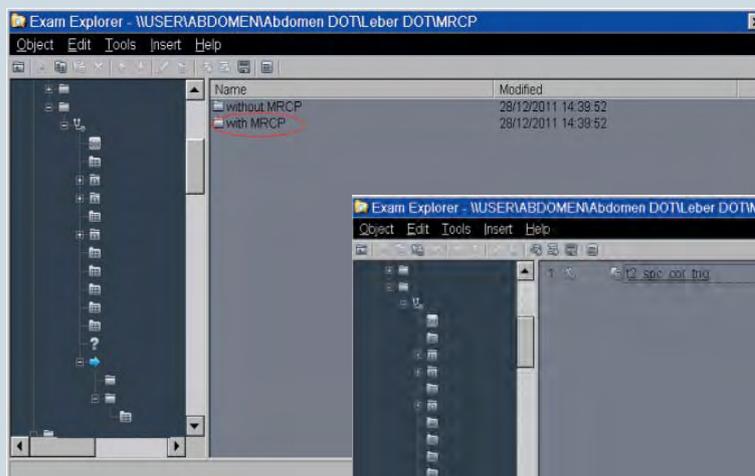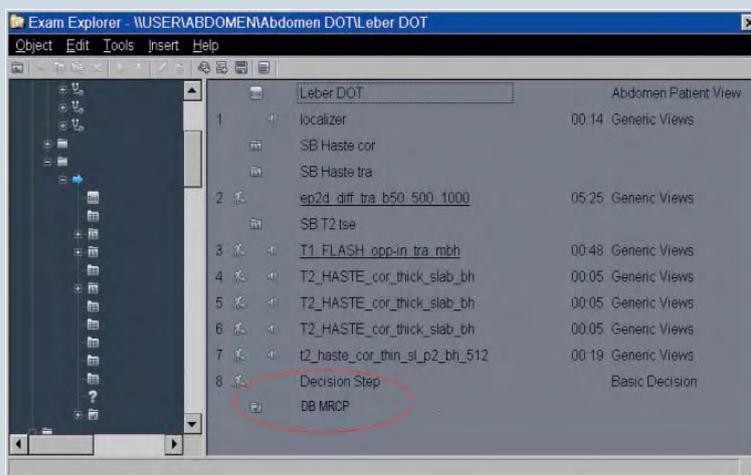

A decision step automatically generates a decision branch. However, a clinical decision point, in this case MRCP, always must be selected under "Decision" for this purpose. The clinical decision point must however already be defined in the patient view.
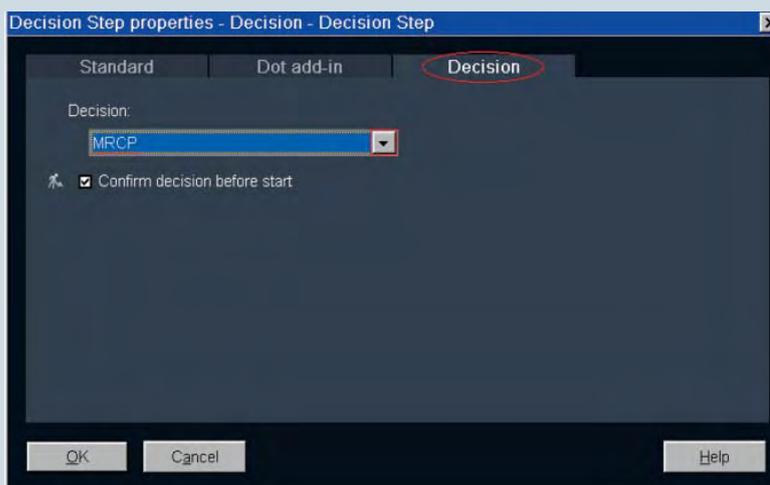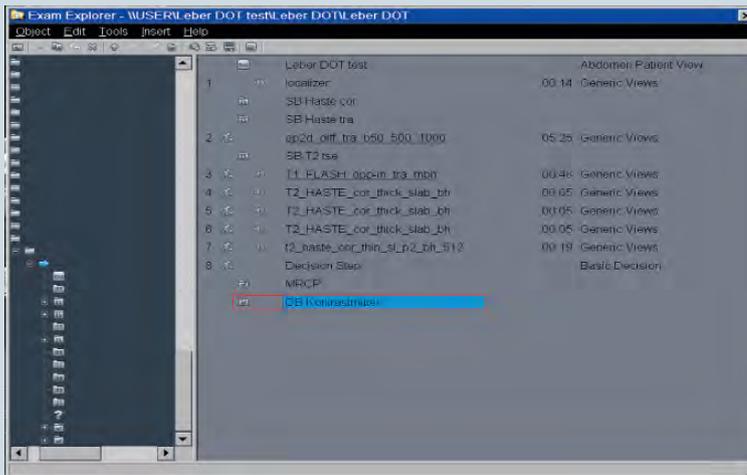
Step 8:

Insert a decision branch for contrast medium administration and save the VIBE protocols for the dynamic contrast medium examination there.
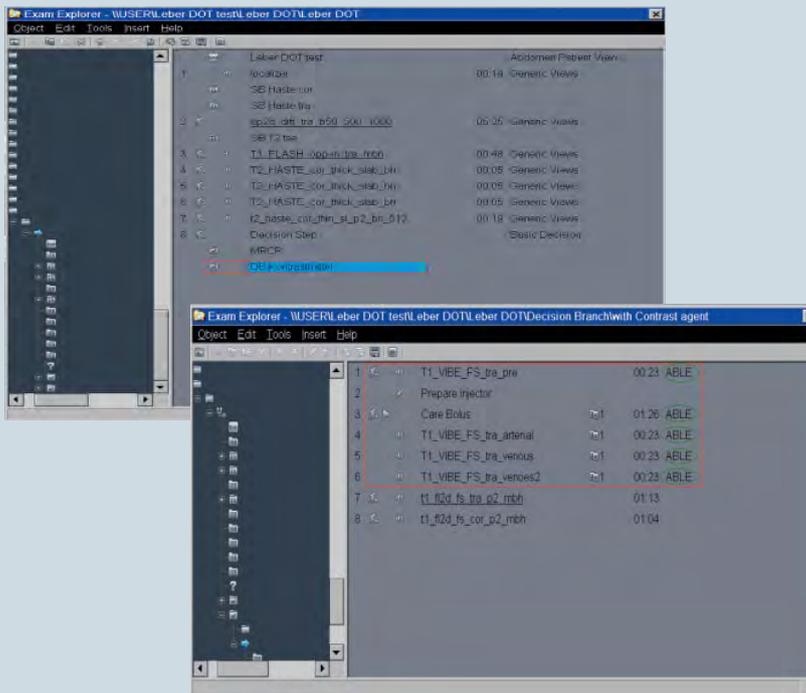
The VIBE is assigned the Dot add-in ABLE. The VIBE always contains 4 measurements (vibe native, vibe arterial, venous and equilibrium). Additional VIBEs cannot be integrated in ABLE.
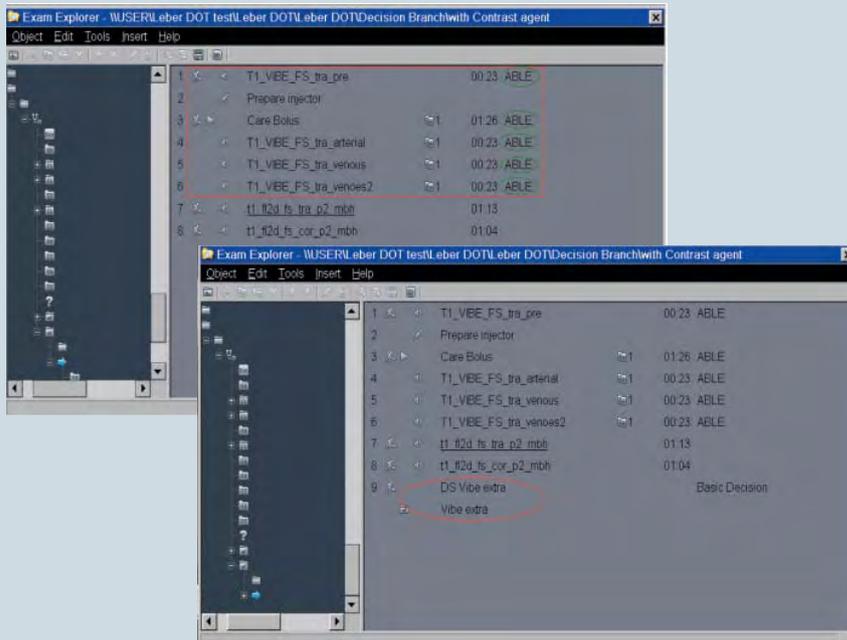

It is, however, possible to equip additional VIBEs with a generic view add-in and attach them to the examination.

Step 9:

Fill the basic framework with sequences. Measurements which are the same for all strategies and are not subject to any further decisions can be inserted under the Dot engine without a strategy branch.
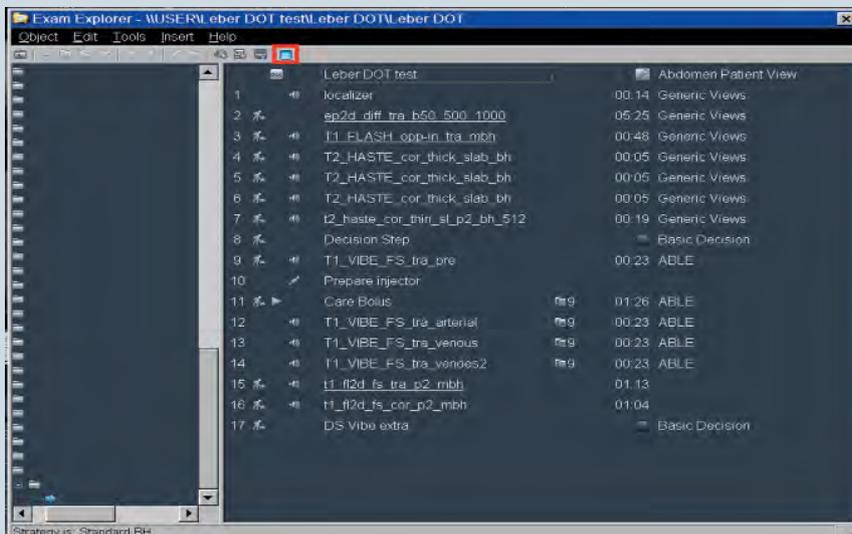
## Special features of the liver Dot engine

Automatic adaptation
The automatic adaptation can be switched off completely or, as an alternative, either the AutoFOV or the breath-hold command can be used separately. This setting also can be changed during the course of the examination.
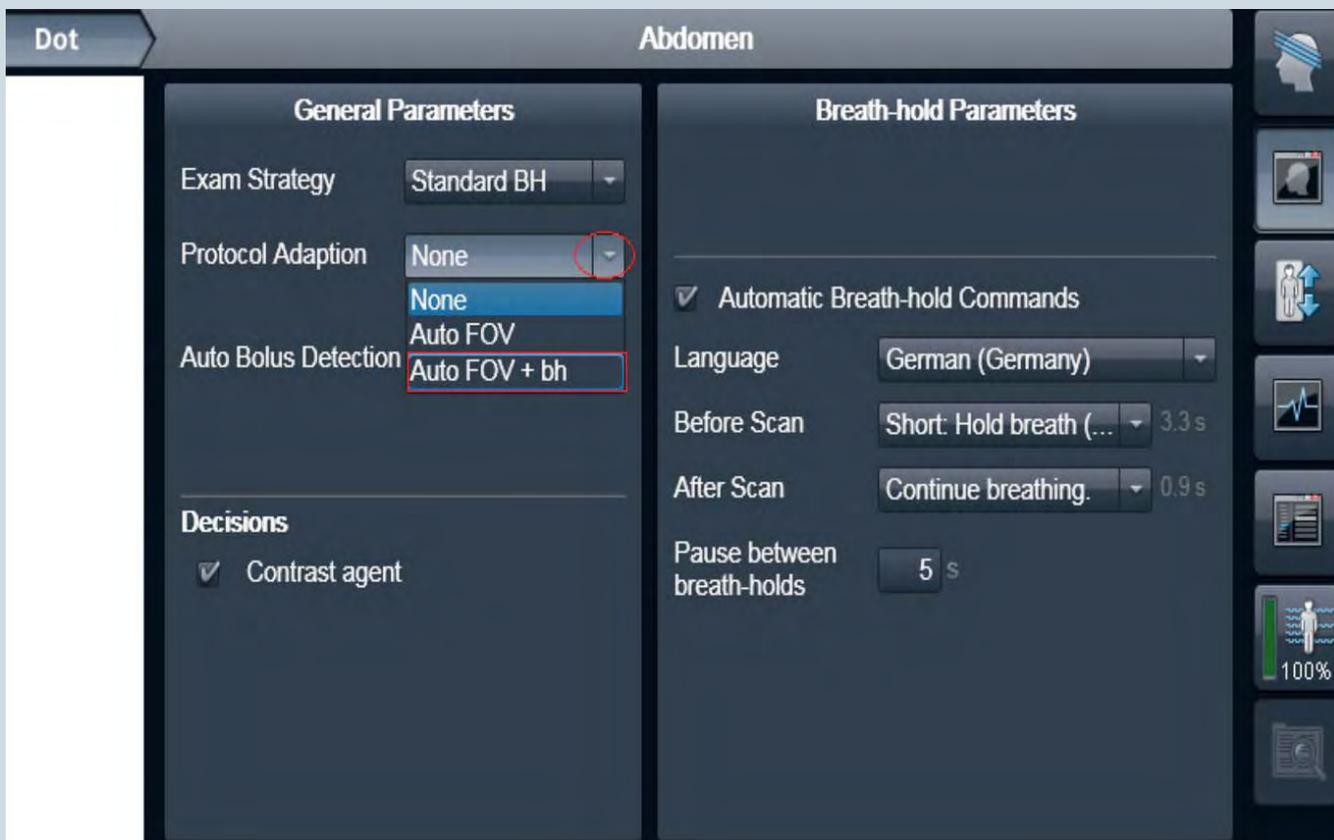
Guidance | Parameters

Position the slice and the ROI for Care Bolus:

1. Select the sagittal slice with the best vessel visualization.

2. Position the ROI in the sagittal slice with a left mouse click (if **Auto Bolus Detection** is on).

3. Adjust slice position for Care Bolus.

4. Start Care Bolus and then start the contrast agent injection.
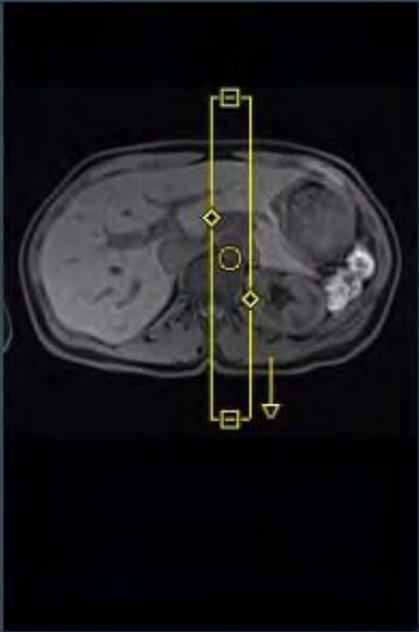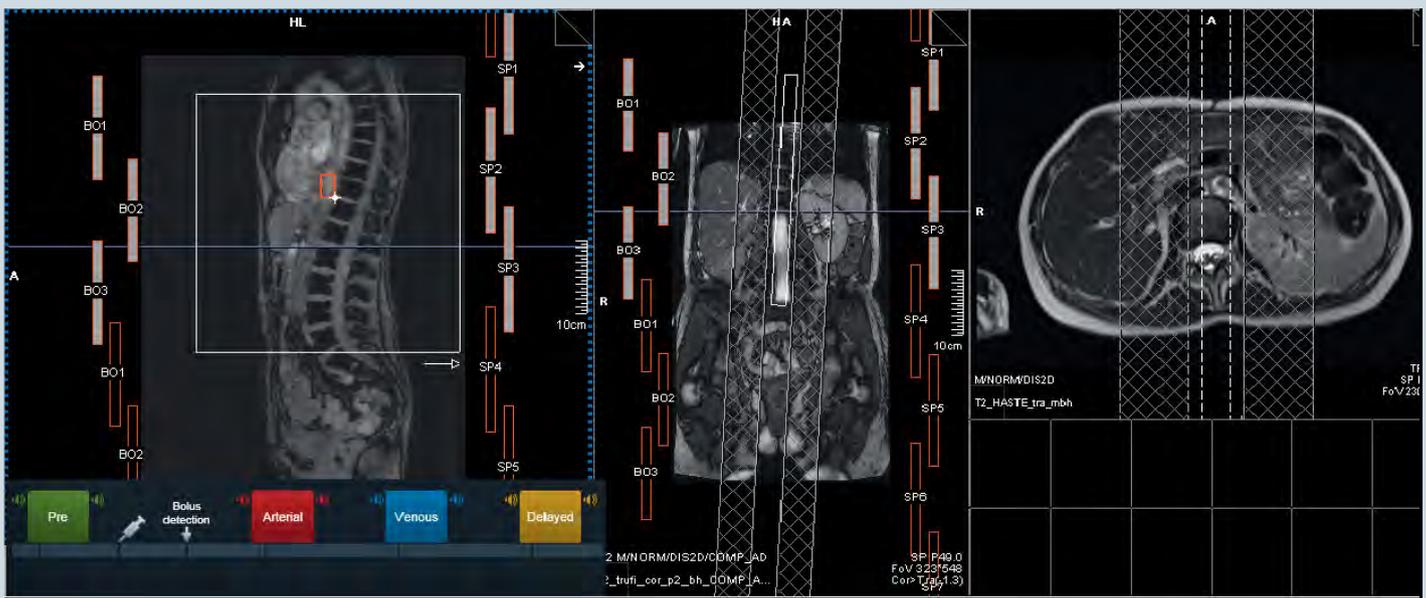
**Automatic execution of contrast-medium-supported sequences**
The guidance images specify optimal positioning of the ROI. Thus oriented, the ROI on the sagittal image is placed in the ascending aorta.
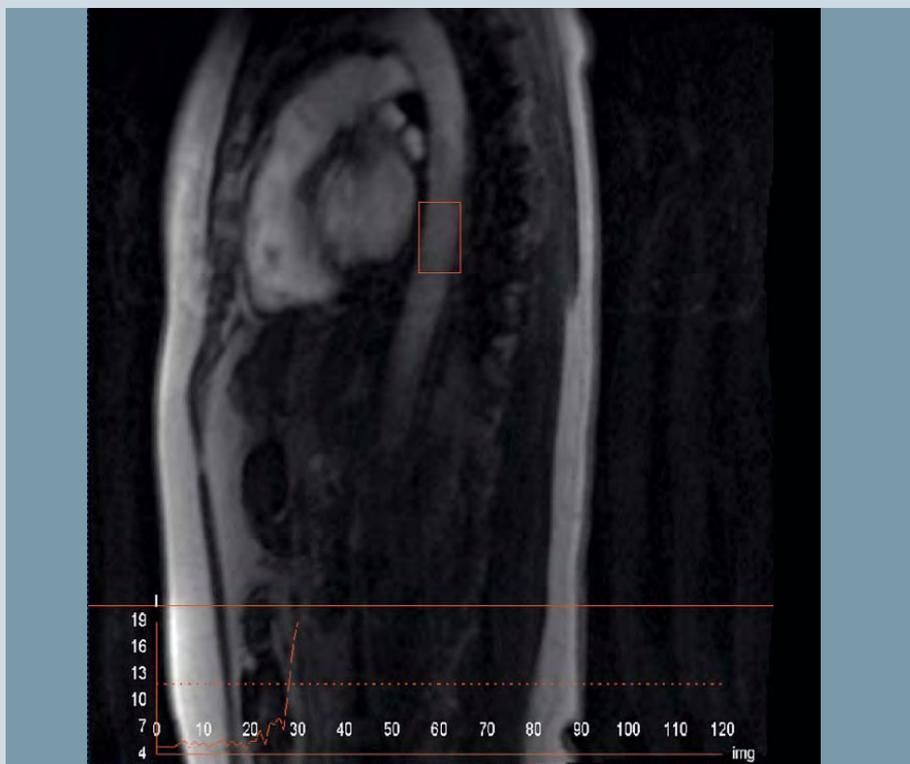
Once the VIBE has been started, the examination is then executed fully automatically. The enhancement curve displays the increase of the contrast medium and can be used to check that the arterial VIBE starts in time. The rest of the examination is performed automatically and can be followed on the graphic display.

Conclusion

In conclusion it can be said that, from the perspective of the technologists, Dot simplifies examination workflows considerably. And it's even more important to know that you can use Dot to make your work a lot easier. We hope that this introduction marked a first step towards familiarizing you with the Dot application. We hope you will have lots of fun creating your own Dot programs tailored to your own individual standards.
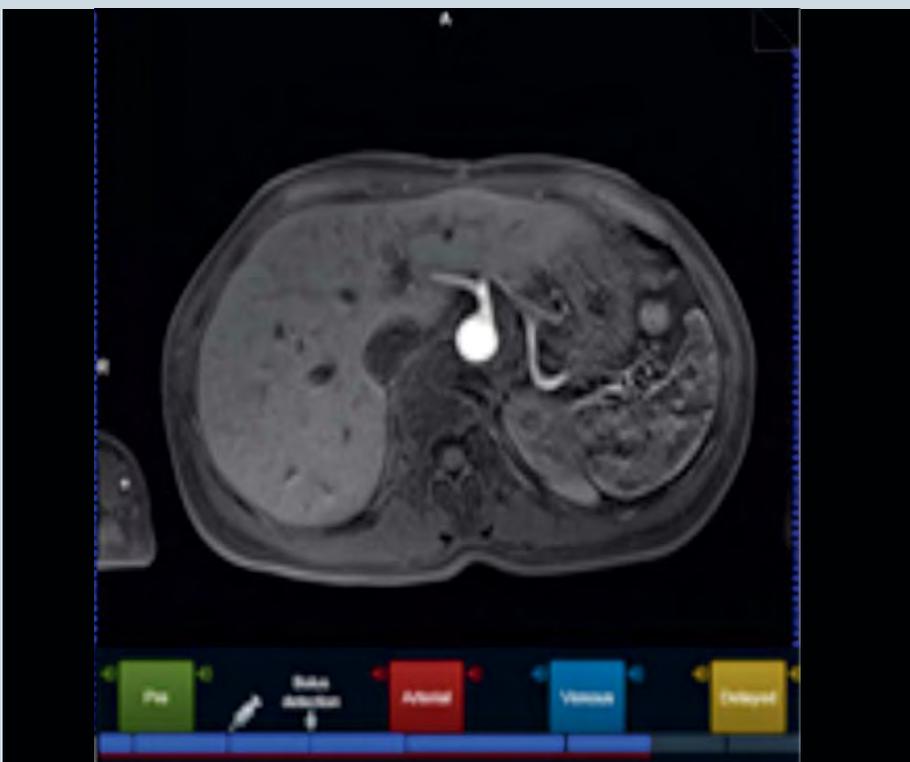
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