III. Discussion and Conclusion

A Principal advantages

Access to different injection modes for the same procedure:
- pure
- diluted
- pulsed
- combination of the above three modes

During an interventional radiological procedure, the switch from angiographic mode to C-arm CBCT mode is necessary to improve guidance and to measure the effectiveness of the interventions. Meeting the dilution requirements of each injection protocol without having to change the syringe barrel means time and, potentially, consumables can be saved. The Accutron HP-D allows optimisation of injection parameters and meets the procedure requirements.

Reduction of artefacts in C-arm CBCT images

The use of diluted contrast medium means artefacts on images can be reduced.

Simple and intuitive programming mode

The choice of contrast medium concentration (pure or diluted) has been integrated in a simple way as one of the injection parameters directly programmable either via the device or via the remote control.

B Limitations

System preparation time:

Setting up the injection syringes by the electroradiology operator takes longer than with single-barrel injectors. This is due to the preparation of the Accutron HP-D system and, in particular, the complete flush of the two syringes. However, the dilution of the contrast medium with the physiological saline is performed automatically in the tube at the time of the injection without additional handling. With a single-barrel injector, the dilution of the contrast medium with physiological saline must be carried out manually before each diluted injection. In addition, the new single-barrel injectors do not allow for the option of performing pulsed injections.

Rigid tube

The Accutron HP-D bifurcated tube is more rigid than the reinforced tubes, but more transparent, making it easier to spot air bubbles during the flush phase.

Taking into account the dead volume in pulsed mode for an injection of 100% pure contrast medium

The dead volume in the injection tube (approximately 5 ml) and the obligatory flush by pure contrast medium leads to modifications in the injection parameters for volumes less than 8 ml. This parameter needs to be integrated into the injection protocol. However, taking the dead volume into account can make it possible to reduce injection volumes of ICM for injections of more than 8 ml using pulsed mode.
Accutron HP-D
Contrast medium injector

I. Hepatic chemoembolisation (TACE)

Hepatic chemoembolisation is a treatment of primary or secondary liver tumours. It consists of accurately administering a combination of embolisation and chemotherapy agents. It is essential to be able to visualise the tumour and its size and identify the pedicles that vascularise it. This is what determines the success or otherwise of the intervention. Furthermore, identifying the collateral non-hepatic arteries (right gastric and cystic arteries) means potential complications can be avoided by a correct positioning of the catheter. The preliminary angiogram and, now, the information provided by C-arm CBCT increase the precision of the procedure, provided that the contrast medium injection is optimal.

A Six TACE procedures were performed with an Accutron HP-D injector and compared to six TACE procedures performed with a classic single head injector. Angiography with preformed catheter (Terumo, Cook) 5Fr:

> Angiography acquisition protocol:
  • Pure mode:
    - Selective injection of the coeliac artery and superior mesenteric artery: ICM 20 ml, 7 ml/s, 900 PSI.
  • Pulsed mode:
    - PVBl mode to measure blood volume (PVBl Siemens) of the liver and tumours. Through two successive acquisitions, this software makes it possible to determine the blood volume of tumours through parametric coloured images. This tool makes it possible to predict the tumour response after TACE. A first acquisition without contrast medium was followed by a second with contrast medium, with the following parameters:
      > PVBl acquisition protocol
        - Super-selective injection by a 2.7 Fr microcatheter (Terumo prograde) into the left and right hepatic arteries. Two rotations of C-arm CBCT of 5 seconds around the patient.
      • Dilution and flush mode:
        - Phase 1: Iomeprol 350 ICM concentration at 28% (12 ml, plus physiological saline 2 ml, 3 ml/s, 300 PSI).
        - Phase 2: Physiological saline flush 5 ml, 3 ml/s, 300 PSI.
        - Scan delay: 12 sec.

B Six cases of use of C-arm CBCT with perfused blood volume (PVBl) acquisition protocols (increased blood volume in mg of blood by 100 mg of tissue):

PVBl mode to measure blood volume (PVBl Siemens) of the liver and tumours. Through two successive acquisitions, this software makes it possible to determine the blood volume of tumours through parametric coloured images. This tool makes it possible to predict the tumour response after TACE. A first acquisition without contrast medium was followed by a second with contrast medium, with the following parameters:

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  • Dilution and flush mode:
    - Phase 1: Iomeprol 350 ICM concentration at 28% (12 ml, plus physiological saline 2 ml, 3 ml/s, 300 PSI).
    - Phase 2: Physiological saline flush 5 ml, 3 ml/s, 300 PSI.
    - Scan delay: 12 sec.

C Six cases of use of C-arm CBCT. Dual phase acquisition protocol (Philips):

The dual-phase approach developed by Philips makes it possible to obtain a vascular mapping of the tumours and to detect these tumours during two successive rotations of the C-arm. A first rotation with injection of pure ICM, immediately followed by an injection of physiological saline were carried out to explore the early arterial phase (vascular network). Then, 17 seconds after the first rotation, a second rotation of the C-arm is performed to explore the enhancement of the tumour (location, vascular aspect, etc.).