Evaluation report

of the double head contrast medium injector Accutron HP-D

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MEDTRON® AG

Evaluation report

Accutron HP-D
Contrast medium injector

INTRODUCTION

The quality of iodinated contrast medium (ICM) injection enables the performance of detailed lesion diagnosis in interventional radiological procedures:

- measurement of the size of a stenosis
- width of the neck and size of an aneurysm
- identification of tumour feeding vessels

Until now, iodinated contrast medium injectors specific to interventional radiology rooms were pumps allowing only pure contrast medium injections at fixed flow rates. The Accutron HP-D has two syringe barrels connected to a bifurcated tube, connected to a mixer. The Accutron HP-D injector can be used for the following types of injection:

- classic injection (pure ICM)
- phased injection (alternating ICM and physiological saline)
- diluted injection (homogeneous ICM dilution, mixed with physiological saline)
- complex injection (dilution and phase)

These options meet the specific needs of new interventional radiology rooms equipped with flat panel detectors. Flat panel detectors have considerably improved image quality. They make it possible to take high-quality angiographic images and furthermore to take CT-like images (C-Arm CBCT, C-arm Cone Beam Computed Tomography). These images are acquired by rapid rotation (between 4 and 8 seconds) of the C-arm around the patient. C-Arm CBCT scans have considerably changed interventional radiological operating practices. The excellent signal resolution (5 to 10 HU) of C-arm CBCT, combined with intra-arterial injection, requires lower ICM concentrations than those used for 2D angiography. In an interventional radiological procedure, the operator switches constantly from angiographic mode to C-arm CBCT mode. An ad hoc ICM dilution is required for each use. The injection of ICM in these interventional radiological procedures is therefore crucial and the possibility of adjusting the dilution of the ICM injected offers considerable added value.

The aim of this study is to evaluate the suitability and quality of ICM injections in different interventional radiological procedures using either the Accutron HP-D contrast medium injector (manufactured by MEDTRON AG) or a classic single head contrast medium injector (from another manufacturer).

STUDY

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.

> Angiogram acquisition protocol:

- Pure mode:

Selective injection of the coeliac artery and superior mesenteric artery: ICM 20 ml, 7 ml/s, 900 PSI.

No difference in image quality was observed by the operators for classic angiographic mode. Good visualisation of principal and secondary trunks, portal return visible, quality adequate.

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

PBV mode to measure blood volume (PBV 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:

> PBV acquisition protocol:

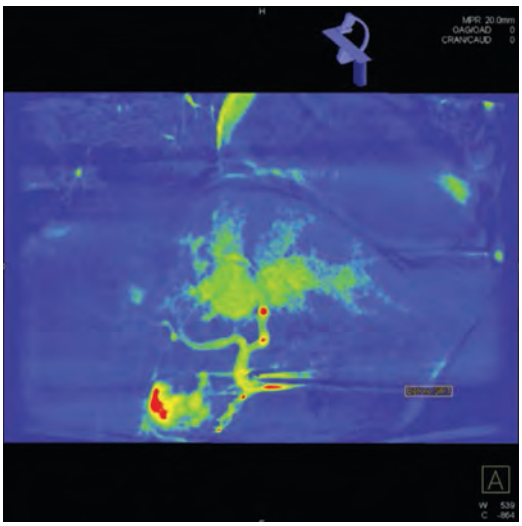
Super-selective injection by a 2.7 Fr microcatheter (Terumo progreat) into the left and right hepatic arteries. Two rotations of C-Arm CBCT of 5 seconds around the patient.

- Dilution and flush mode:

Phase 1: Iomeprol 350 ICM concentration at 28% (12 ml, plus physiological saline 32 ml), total injection volume 44 ml, 3 ml/s, 300 PSI.

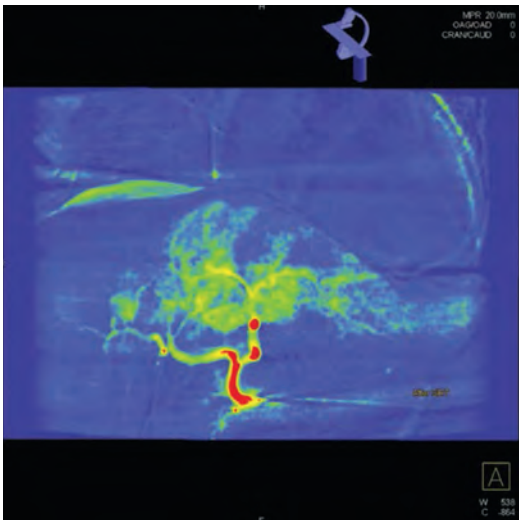
Phase 2: Physiological saline flush 5ml, 3 ml/s, 300 PSI.

Scan delay: 12 sec.



CBCT imaging to evaluate the blood volume of the liver and tumours in a patient referred for radioembolisation of a hepatocellular carcinoma (HCC). Injection performed in diluted mode. These parametric images make it possible to objectively assess the tissue perfusion of the target organ.

No difference in image quality was observed; the operators were easily able to measure the blood volume of the liver and tumours. A substantial reduction in artefacts was observed.



CBCT imaging after administration of radioembolisation to assess blood volume of the liver and tumour in a patient referred for radioembolisation of a HCC. Injection performed in diluted mode. These parametric images make it possible to objectively assess the tissue perfusion of the target organ. Here, we note a substantial reduction in blood volume of the tumour and increased blood volume of the hepatic tissue and left lobe. This illustrates both the embolisation of the tumour and the buffer effect of the healthy liver.

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.).

> Dual-phase acquisition protocol:

Super-selective injection by a 2.7 Fr microcatheter (Terumo progreat) into the common hepatic artery. Two rotations of the C-Arm.

Five-second CBCT around the target.

- Dilution and flush mode:

Phase 1: Iomeprol 350 diluted to 50%; total injection volume 15 ml, ICM 8 ml, physiological saline 8 ml, 3ml/s, 300 PSI, scan delay 0.

Phase 2: Physiological saline flush 15 ml, 3 ml/s, 300 PSI.

A substantial improvement in image quality was observed. This is due to the dilution of the ICM during the first acquisition phase (very clear reduction in artefacts linked to the density of the ICM). In addition, the physiological saline flush performed at the end of the injection creates better visualisation of the tumour partly because there are no artefacts and partly because the ICM is no longer in the arteries.

II. Venograms

Four venograms of the upper/lower limbs (mapping of the veins before gaining intravenous access for haemodialysis) and central venous trunks were performed with the Accutron HP-D in pulsed mode.

Upper limbs:

- *Diluted and pulsed mode:*

Phase 1: *Iodixanol 320 diluted to 50%; total injection volume 30 ml, ICM 15 ml, physiological saline 15 ml, 4 ml/s, 300 PSI, scan delay 0.*

Phase 2: *Phase 2: Physiological saline 30 ml, 3 ml/s, 300 PSI.*

Lower limbs:

- *Pulsed mode:*

Phase 1: *Total injection volume 40 ml, ICM (Iodixanol 320) 40 ml, 4 ml/s, 300 PSI, scan delay 0.*

Phase 2: *Physiological saline 40 ml, 4 ml/s, 300 PSI.*

Central venous trunks:

- *Pulsed mode:*

Phase 1: *Total injection volume 20 ml, ICM (Iodixanol 320) 20 ml, 4 ml/s, 300 PSI, scan delay 0.*

Phase 2: *Physiological saline 20 ml, 4 ml/s, 300 PSI.*

The diluted and pulsed modes enable higher quality image acquisition than classic injection. In addition, a reduction of 50 to 60% in the volume of ICM is obtained by this method compared to a classic injector; this represents a major benefit to the patient.

Figure 1 –Venogram of the deep venous trunks in pulsed mode. Complete re-occlusion of the Superior Vena Cava (SVC) in a patient with tumoral stenosis.

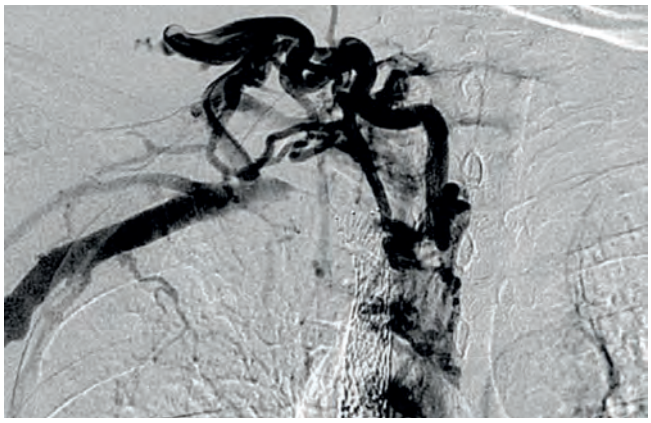


Figure 2 – Venogram of the deep venous trunks in pulsed mode, delayed image. Complete re-occlusion of the SVC in a patient with tumoral stenosis.

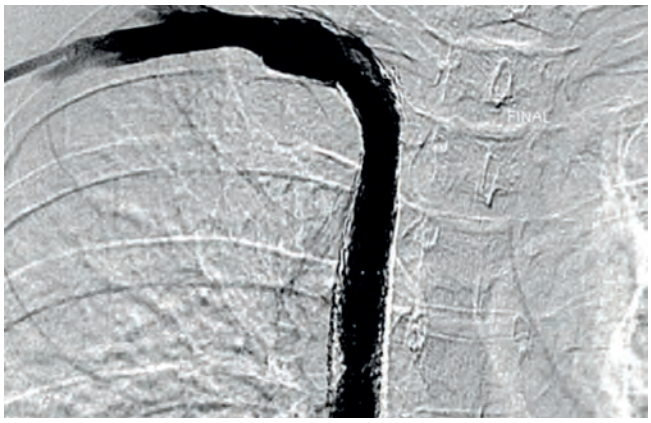


Figure 3 – Venogram of the deep venous trunks in pulsed mode. After canalisation and angioplasty of the SVC.

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.