InnoVatE Study

The impact of CT injection system technology and contrast media viscosity on vascular enhancement

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medrad® Centargo
CT Injection System

InnoVatE Study: The first peer-reviewed publication investigating combined performance of CT injection systems and contrast media[1]

Evaluating key performance metrics for vascular imaging

- Maximum achievable iodine delivery rates (IDRs)
- Peak vascular enhancement

By comparing

- Piston-based vs. peristaltic pump injection system technology[2]
- Contrast media across a broad range of concentrations and viscosities

1 McDermott et al. Impact of CT Injector Technology and Contrast Media Viscosity on Vascular Enhancement: Evaluation in a Circulation Phantom. Br J Radiol 2020;93: 20190868

2 MEDRAD® Centargo CT Injection System ('Centargo'), MEDRAD® Stellant CT Injection System with the Multi Patient Kit ('Stellant MP'), Bracco CT Exprès® Contrast Injection System with Multi Patient Set ('CT Exprès'), ulrich CT motion™ Contrast Media Injector ('CT motion')

What is Iodine Delivery Rate (IDR)?

Injection protocols are programmed in terms of flow rate and volume, however this convention ignores the impact of contrast concentration.

IDR represents the **amount of iodine delivered to the patient per second**. It is the product of injection flow rate and contrast media concentration.

Concentration		Flow Rate		IDR
0.37 370 milligrams Or 0.37 grams of iodine per milliliter	X	**5** milliliters per second	=	**1.85** grams of iodine per second

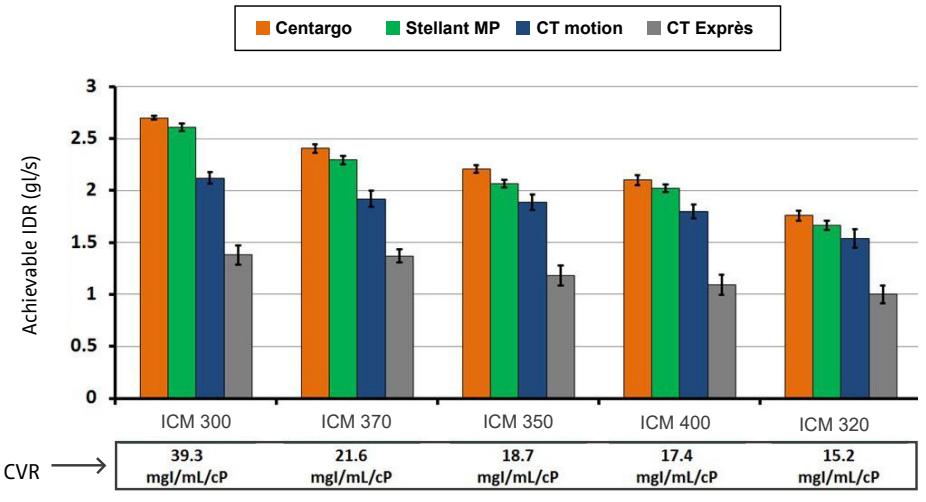
Example

- IDR is the key parameter in first-pass imaging, such as CT Angiography.
- Typical clinical ranges are 1.0 – 2.0 gI/s, with variability based on indication, patient size, and scanner settings.
- The ability to achieve a wide range of IDRs provides the most flexibility for challenging studies, especially for larger patients.

Experiment I – Maximum Achievable Iodine Delivery Rates (IDRs)

- Piston-based injection systems achieve significantly higher IDRs than the peristaltic pumps ($p < 0.05$). Also, increasing contrast media concentration does not increase the achievable IDR, as higher viscosities require higher pressures to achieve the same flow rates.
- This study introduces a new parameter to better predict performance: the **concentration/viscosity ratio (CVR)**.

Maximum Achievable IDR vs. Injection System with Various Iodinated Contrast Media (ICM)



Piston-based injection systems, MEDRAD® Centargo and MEDRAD® Stellant MP provide higher achievable IDRs as compared to the peristaltic pump-based systems, CT motion and CT Exprès.

What is Concentration / Viscosity Ratio (CVR)?

Concentration and viscosity are two physical properties of CT contrast media.

The InnoVatE study introduces the concentration/viscosity ratio (CVR) as a new parameter for comparing contrast media performance in achievable IDRs.

Concentration
370
370 milligrams of Iodide per milliliter (mgI/mL)

÷

Viscosity
17.10
Measured viscosity in centipoise (cP)

=

CVR
21.6
Concentration/ Viscosity Ratio (mgI/mL/cP)

Example

Generic	Concentration (mgI/mL)	Published Viscosity (cP)*	Measured Viscosity (cP)**	Concentration / Viscosity Ratio (mgI/mL/cP)***	Concentration / Viscosity Ratio (mgI/mL/cP) at 37°C****
ICM	300	9.2	7.64	39.3	61.2
ICM	320	26.6	21.10	15.2	27.1
ICM	350	20.4	18.70	18.7	33.7
ICM	370	22.0	17.10	21.6	37.0
ICM	400	27.5	23.00	17.4	31.7

* Official data from manufacturers at 20°C
** Measured data using Brookfield DV-II+ Pro Viscometer at tested temperature of 21.5°C
*** Determined using measured contrast media viscosity
**** Calculated from manufacturer reported viscosities at 37°C

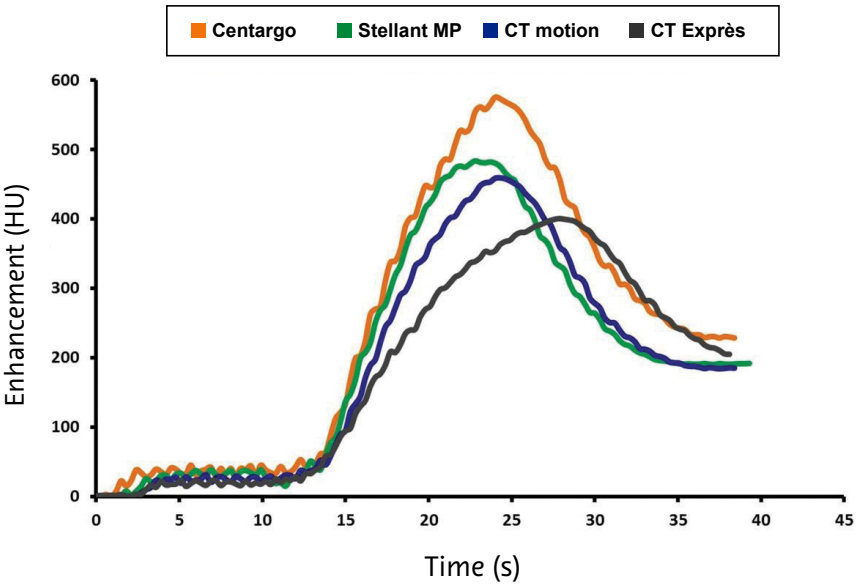
The results in this study show that CVR better predicts achievable IDRs than concentration alone.

Experiment II – Effect of Achievable IDR on Peak Vascular Enhancement

Key Term: A cardiovascular circulation phantom is a well-accepted research tool that simulates the transport and distribution of contrast material through the human circulatory system.

- The phantom provides a link between achievable IDRs and image enhancement, by allowing measurement of enhancement in large vessels.
- Centargo provides the highest peak vascular enhancement (up to a 48% increase) when compared to the tested peristaltic injectors with programmed IDRs from 1.8 – 2.4gl/s ($p < 0.05$).

Example Aortic Enhancement Graph Comparing Injection Systems



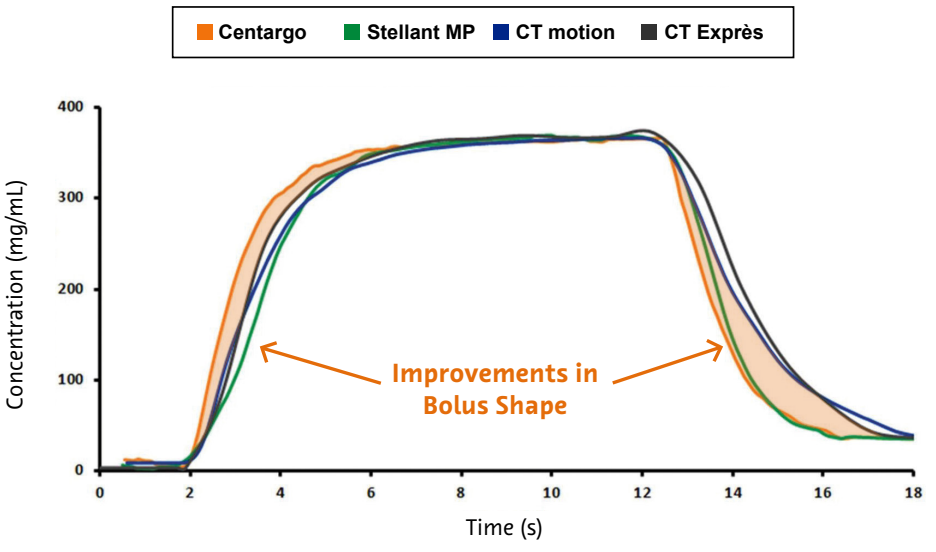
Centargo is capable of achieving higher IDRs, providing significantly higher enhancement for a longer duration.

Experiment III – Effect of Bolus Shape on Peak Vascular Enhancement

Key Term: Bolus shape represents the iodine concentration entering the patient over the duration of the injection.

- Centargo demonstrates a sharper and more compact bolus, with a faster rise time and fall time.
- The orange highlighted portion of the graph represents the bolus shape improvement of Centargo vs. the peristaltic pumps.
- This improvement in bolus shape leads to significant increases in enhancement in most tested protocols from 1.5 – 2.0 gI/s ($p < 0.05$).

Example Graph of Bolus Shape vs. Injection System



Centargo demonstrates improved bolus shape as compared to the other tested systems, exhibiting a faster rise time and faster fall time.

The results demonstrate superiority of piston-based injection systems and the importance of contrast media viscosity.

- Piston-based injection systems allow for higher achievable IDRs than the tested peristaltic pumps, leading to significantly increased peak vascular enhancement (up to 48%).
- Contrast media viscosity is more important than concentration, as higher concentration/viscosity ratios (CVRs) allow for higher achievable IDRs.

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CE 2797

Bayer AS - Norge
Drammensveien 288
Postboks 193
NO-1325 Lysaker
Tel: +47 22 06 57 10
radiology.bayer.no

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