InnoVatE Study

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

Clear Direction. From Diagnosis to Care.

Ultravist®
Iopromide

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.

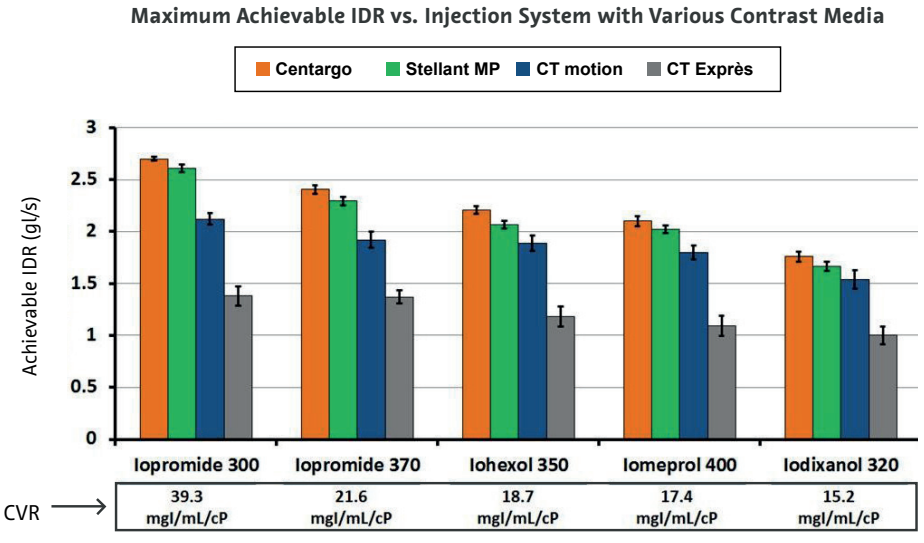
Concentration		Flow Rate		IDR
0.37 370 milligrams or 0.37 grams of iodine per millilitre	X	**5** millilitres per second	=	**1.85** grams of iodine per second

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)**.



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.

Example

Ultravist 300 and Ultravist 370 have the highest CVRs among the tested contrast media at room temperature and also when heated to 37°C.

Generic	Brandname	Concentration (mgI/mL)	Published Viscosity (cP)*	Measured Viscosity (cP)**	Concentration / Viscosity Ratio (mgI/mL/cP)***	Concentration / Viscosity Ratio (mgI/mL/cP) at 37°C****
Iopromide	Ultravist	300	9.2	7.64	39.3	61.2
Iodixanol	Visipaque	320	26.6	21.10	15.2	27.1
Iohexol	Omnipaque	350	20.4	18.70	18.7	33.7
Iopromide	Ultravist	370	22.0	17.10	21.6	37.0
Iomeprol	Iomeron	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.

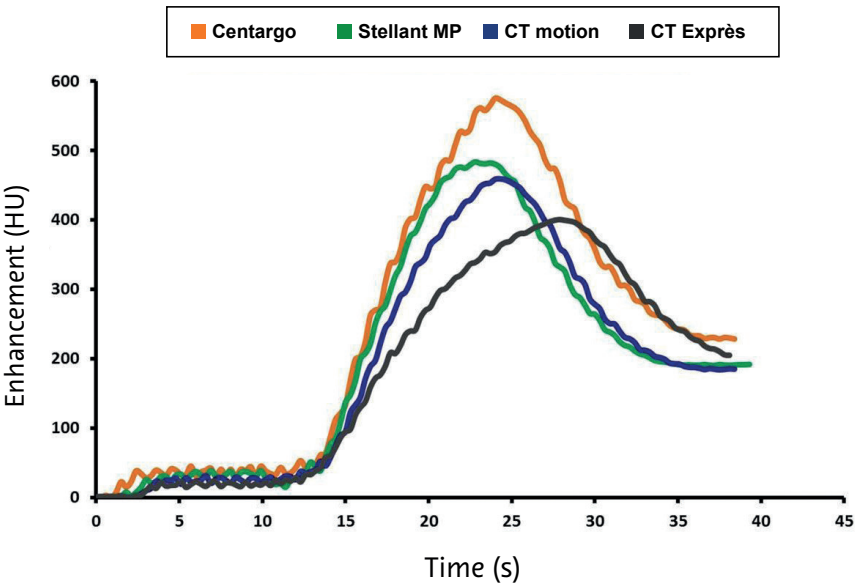
Ultravist® (iopromide) 300 and Ultravist® 370 provide the highest achievable IDRs among the tested contrast media due to their high concentration/viscosity ratios (CVRs).

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 – 2.4gI/s ($p < 0.05$).

Example Aortic Enhancement Graph Comparing Injection Systems



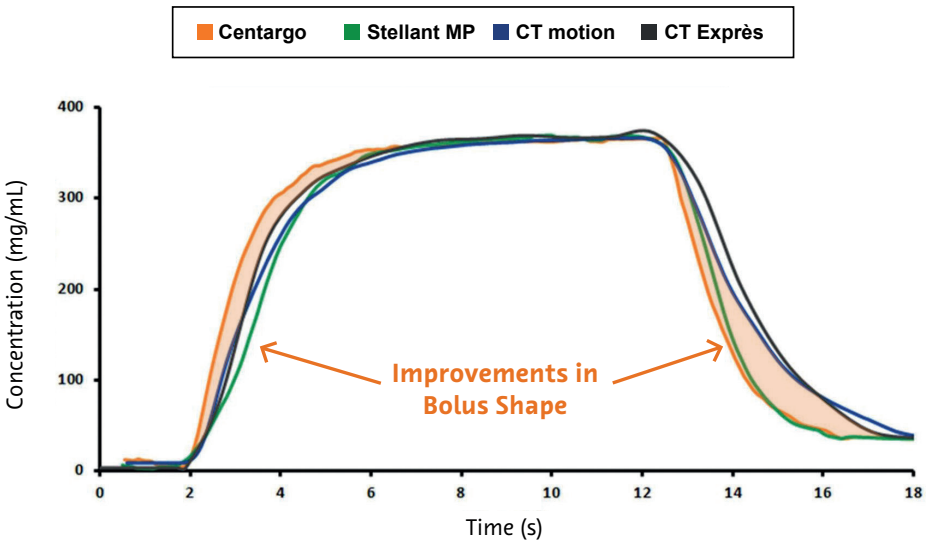
Centargo is capable of achieving higher IDRs, providing significantly higher enhancement for a longer duration.

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.

PBS Information: This product is not listed on the PBS.

ULTRAVIST® (iopromide)
INDICATIONS: ULTRAVIST is indicated for all angiographic and urographic examinations and for contrast enhancement in computerised tomography. ULTRAVIST 240 is additionally indicated for lumbar myelography in adults. **CONTRAINDICATIONS:** known hypersensitivity or previous reaction to iodinated contrast media or excipients, immediate repeat myelography. **PRECAUTIONS:** anaphylactoid/hypersensitivity or other idiosyncratic reactions; pretesting/sensitivity testing is not recommended, evaluate potential risk of hypothyroidism in patients with known or suspected thyroid dysfunction, monitor thyroid function in neonates who have been exposed to ULTRAVIST; patients with CNS disorders, exercise caution in situations of reduced seizure threshold; patients with pronounced states of excitement, anxiety and pain; patients with significant cardiac disease or severe coronary artery disease; thromboembolic events; patients with severely impaired renal function, combined renal and hepatic disease, combined renal and cardiac disease, anuria or when large doses are administered; ensure adequate hydration status before i.v. or i.t. administration to minimise PC-AKI and especially in renally impaired patients; patients with known or suspected pheochromocytoma; intravascular use in patients with autoimmune disorders, myasthenia gravis, cerebral angiography or peripheral angiography; intrathecal use in patients with seizure history; not for use in thoracic, cervical or total columnar myelography, cerebral ventriculography or cisternography; paediatrics; pregnancy (Category B2); effects on diagnosis and treatment of thyroid disorders with thyrotropic radioisotopes; avoid driving or operating machinery for the first 24 h after administration. **INTERACTIONS WITH OTHER MEDICINES:** metformin; neuroleptics and antidepressants; beta-blockers; interleukin-2. **ADVERSE EFFECTS:** Common: dizziness, headache, dysgeusia, blurred/disturbed vision, chest pain/discomfort, hypertension, vasodilation, vomiting, nausea, pain, injection site reactions, feeling hot. Refer to full PI for a complete list. **DOSAGE AND ADMINISTRATION:** Dosage should be adapted to age, weight, clinical question, examination technique and region to be investigated. Can be used with single-use or multi-patient use injector system. Administration may be intravascular or intrathecal depending on clinical problem and region to be investigated. For intrathecal use in myelography, only ULTRAVIST 240 is recommended and allow at least 48 h before repeat examination. Refer to full PI for details. **DATE OF PREPARATION:** Based on PI dated 17 November 2021.

Please review the full Product Information before prescribing. Approved PI available at https://www.ebs.tga.gov.au/ebs/picmi/picmirepository.nsf/pdf?OpenAgent&id=CP-2020-PI-02293-1 or upon request from Bayer Australia Ltd, ABN 22 000 138 714, 875 Pacific Highway, Pymble NSW 2073, phone 1800 008 757.

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Radiology
Bayer Australia Ltd
875 Pacific Highway
Pymble NSW 2073
Australia
Phone: 1800 008 757
ABN: 22 000 138 714

Manufacturer
Imaxeon Pty Ltd
Unit 1, 38 – 46 South Street
Rydalmere, NSW 2116
Australia
Phone: 02-8845-4999
Fax: 02-8845-4998
Imaxeon is a Bayer subsidiary

Australian Sponsor
Imaxeon Pty Ltd
Unit 1, 38 – 46 South Street
Rydalmere, NSW 2116
Australia
Phone: 02 8845 4999
Fax: 02 8845 4936
Customer Service: 1800 633 723

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