Enhanced clinical efficiency in radiology with protocol optimization & right choice of iodinated contrast media

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Number of CT scans is on the rise[1]

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- From 2007 to 2017, the number of CT examinations rose by an average of 56%.[1]
- Use of iodinated contrast media (ICM) is growing accordingly.[2]
- In Korea alone, it is estimated that more than 4 million CT scans involving contrast use are performed each year.[2]
- Low-osmolar contrast media (LOCM) are the are the most widely used class of CT contrast media.[3]

1. OECD (2019), “CT exams, 2007 and 2017 (or nearest year)”, in Health care activities, OECD Publishing, Paris, https://doi.org/10.1787/da83b311-en.
2. Cha MJ, et al. Hypersensitivity Reactions to Iodinated Contrast Media: A Multicenter Study of 196 081 Patients. Radiology. 2019. Oct;293(1):117-124. doi:10.1148/radiol.2019190485.
3. Becker, C.R. Selecting a contrast medium for MDCT investigation. Eur Radiol Suppl 16, D33–D37 (2006). https://doi.org/10.1007/s10406-006-0185-2

Confidence with Ultravist

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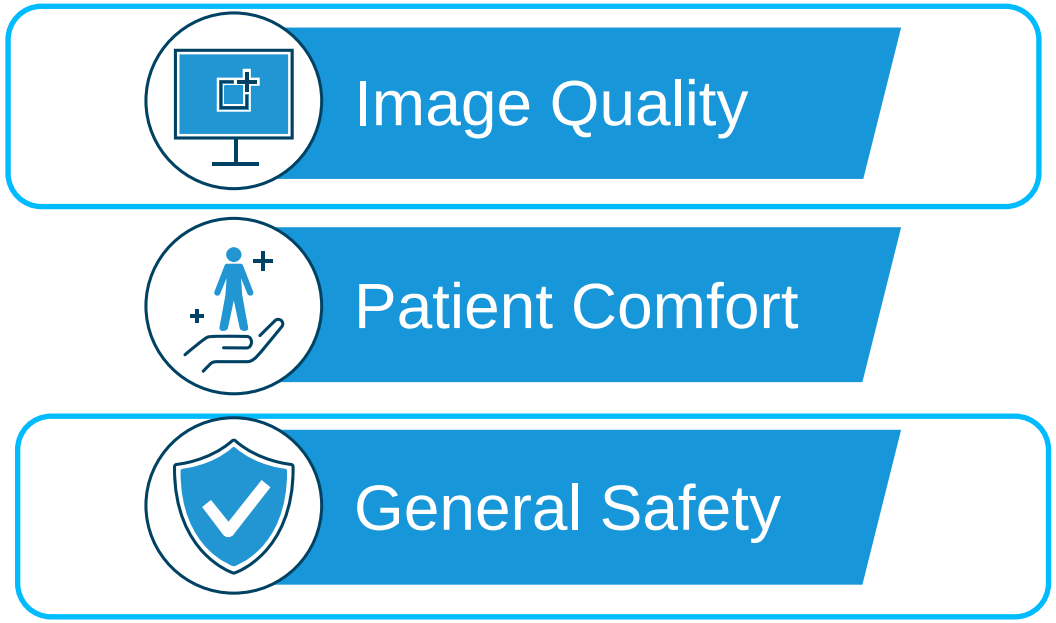
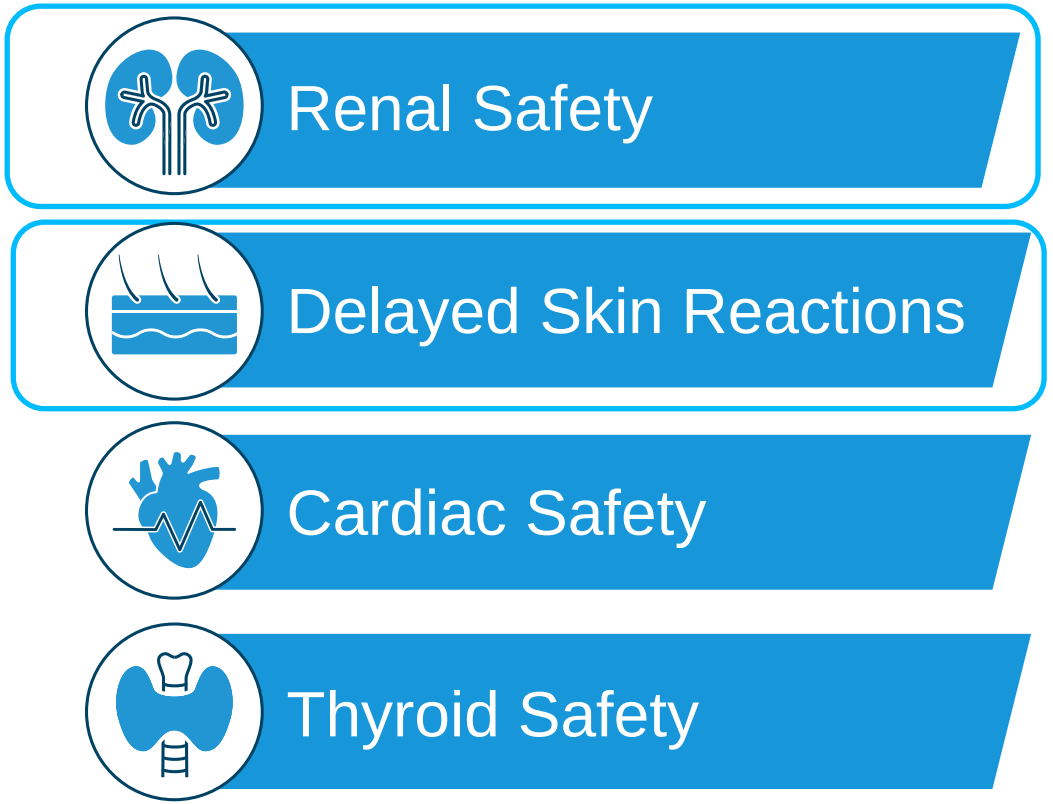
- To diagnose with confidence, it is important to be familiar with the comprehensive data on image quality, patient comfort and safety of contrast media.





Structure, Ionicity & Osmolarity* of Iodinated Contrast Media

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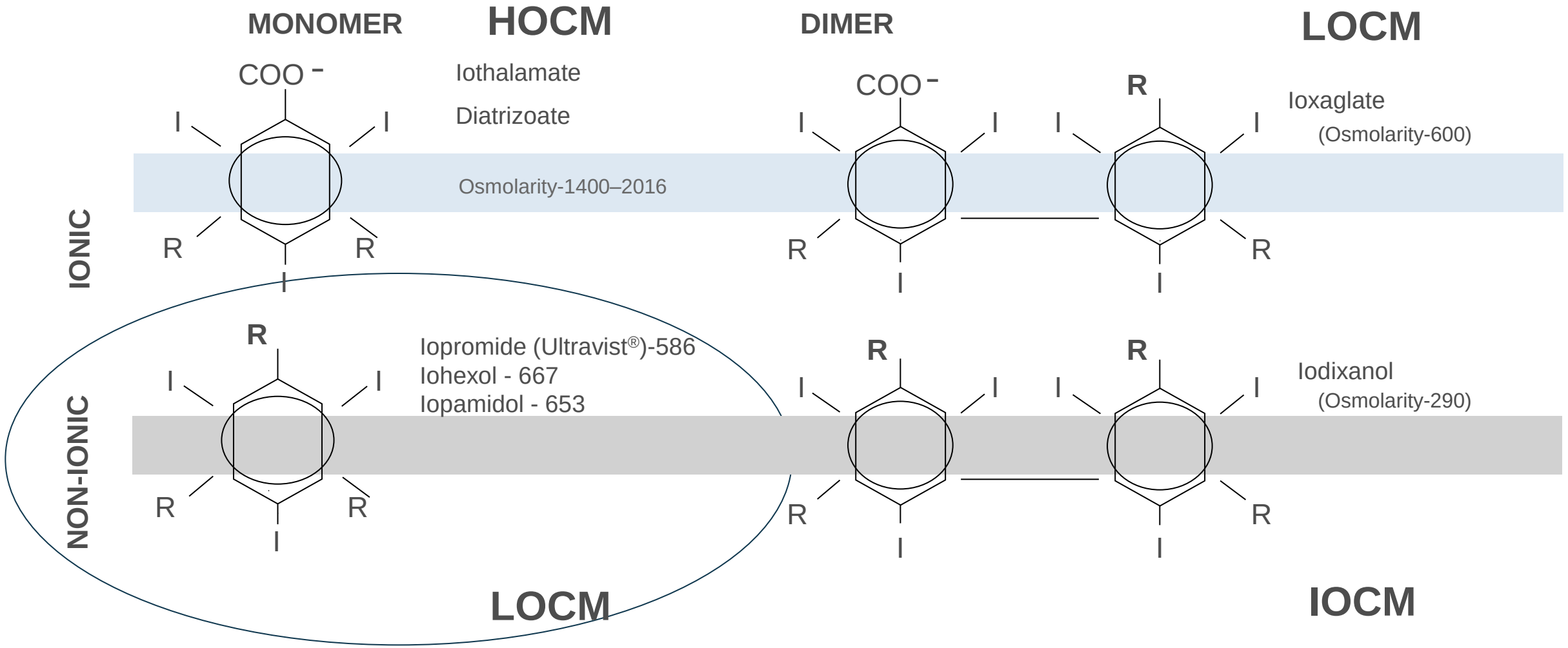

Adapted from- Richard Solomon, "Contrast Media: Are There Differences in Nephrotoxicity among Contrast Media?", *BioMed Research International*, vol. 2014, Article ID 934947, 8 pages, 2014. https://doi.org/10.1155/2014/934947

* Osmolality-(mOsm/kg water)

Physico-chemical properties of Iodinated Contrast Media

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COMPOUND	OSMOLALITY*	VISCOSITY 20 °C	37 °C
Ionic CM			
Diatrizoate	1,502 ± 16	9.3 ± 0.1	4.9 ± 0.0
Ioxaglate 320	584 ± 10	16.2 ± 1.0	7.8 ± 0.4
Non ionic CM			
Iopamidol	640 ± 6	8.4 ± 0.1	4.5 ± 0.0
Iohexol	667 ± 8	10.9 ± 0.2	5.7 ± 0.1
Iopromide	586 ± 5	8.9 ± 0.1	4.7 ± 0.1
Iomeprol	521 ± 24	8.1 ± 0.7	4.5 ± 0.4
Ioversol	661 ± 3	10.1 ± 1.2	5.2 ± 0.6
Iopentol	683± 4	12.9 ± 0.2	6.5 ± 0.1
Iotrolan	294± 3	17.5 ± 0.0	8.5 ± 0.0
Iodixanol	290	25,4	11.1

* Osmolality (mOsm/kg H_2O) for 300 mg Iodine / mL, 37 °C
(mean ± standard deviation, as far as data are available)

Image Quality

Image quality is key

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- High-quality images simplify interpretation and are essential for correct diagnosis and treatment planning.
- The key parameter for a high imaging quality differs for organ studies and imaging of vessels
  - Key parameter for organ studies: Total Iodine Load (TIL)[1]
  - Key parameter in CT angiography: Iodine Delivery Rate (IDR)[2]
- Other aspects to be considered when optimizing protocols are:
  - The patient's body weight[3]
  - Peak pressure[2]
  - Viscosity of the contrast medium (CM)[2]
  - Type of injector used to inject the CM[4]

1. Bae KT. Intravenous contrast medium administration and scan timing at CT: considerations and approaches. Radiology. 2010;256(1):32–61. doi: 10.1148/radiol.10090908
2. Rengo M, et al. Impact of iodine concentration and iodine delivery rate on contrast enhancement in coronary CT angiography: a randomized multicenter trial (CT-CON). Eur Radiol. 2019 Nov;29(11):6109-6118. doi: 10.1007/s00330-019-06196-7 doi: 10.1007/s00330-019-06196-7
3. Hendriks BMF, et al. Individually tailored contrast enhancement in CT pulmonary angiography. Br J Radiol 2016; 89: 20150850. doi: 10.1259/bjr.20150850
4. Chaya A, et al. Piston-Based vs Peristaltic Pump-Based CT Injector Systems. Radiol Technol. 2019 Mar;90(4):344-352. PMID: 30886031

Peak pressure and image quality

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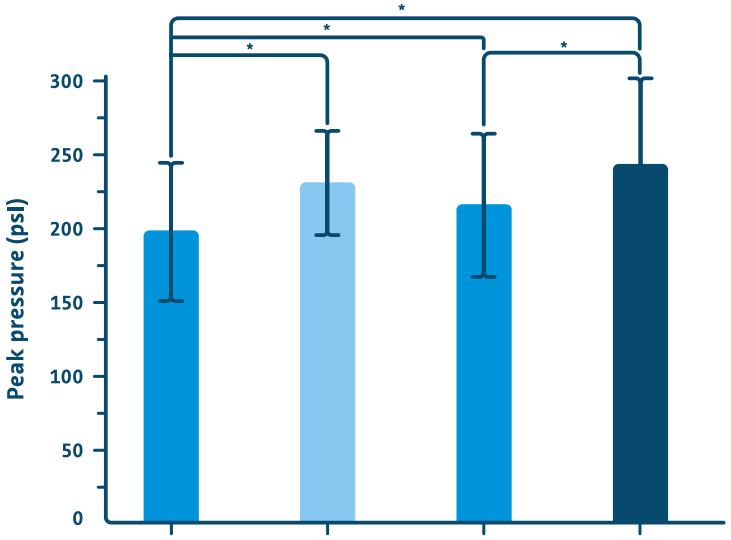
- CT-CON demonstrated that higher iodine concentrated contrast media with simultaneously increased viscosity result in higher peak pressures.[1]
- Lower viscosity is known to be beneficial in terms of injection pressure.[2,3]
- High viscosity complicates the contrast administration at higher flow rates.[4]

High peak pressures should be avoided to achieve optimal image quality.[1]

A low viscosity contrast media is beneficial for the higher flow rates required for CTA examinations.[1,5]



	Iopromide 300 mg/l	Iohexol 350 mg/l	Iopromide 370 mg/l	Iomeprol 400 mg/l
Peak pressure (psi)**	197.4 ± 47.7	229.8 ± 35.7	216.1 ± 46.1	243.7 ± 58.7

Influence of viscosity on peak pressures for different contrast media.[1]

1. Rengo M, et al. Impact of iodine concentration and iodine delivery rate on contrast enhancement in coronary CT angiography: a randomized multicenter trial (CT-CON). Eur Radiol. 2019 Nov;29(11):6109-6118. doi: 10.1007/s00330-019-06196-7
2. Bae KT. Intravenous contrast medium administration and scan timing at CT: considerations and approaches. Radiology. 2010;256(1):32–61. doi: 10.1148/radiol.10090908
3. Kok M, et al. Patient Comfort During Contrast Media Injection in Coronary Computed Tomographic Angiography Using Varying Contrast Media Concentrations and Flow Rates: Results From the EICAR Trial. Invest Radiol. 2016 Dec;51(12):810-815. doi: 10.1097/RLI.0000000000000284
4. Faggioni L, Gabelloni M. Iodine Concentration and Optimization in Computed Tomography Angiography: Current Issues. Invest Radiol. 2016 Dec;51(12):816-822. doi: 10.1097/RLI.0000000000000283 Review. Dec;51(12):810-815.
5. Mihl C, et al. Intravascular enhancement with identical iodine delivery rate using different iodine contrast media in a circulation phantom. Invest Radiol. 2013;48:813–818. doi: 10.1097/RLI.0b013e31829979e8

Ultravist® – a good choice to apply IDR

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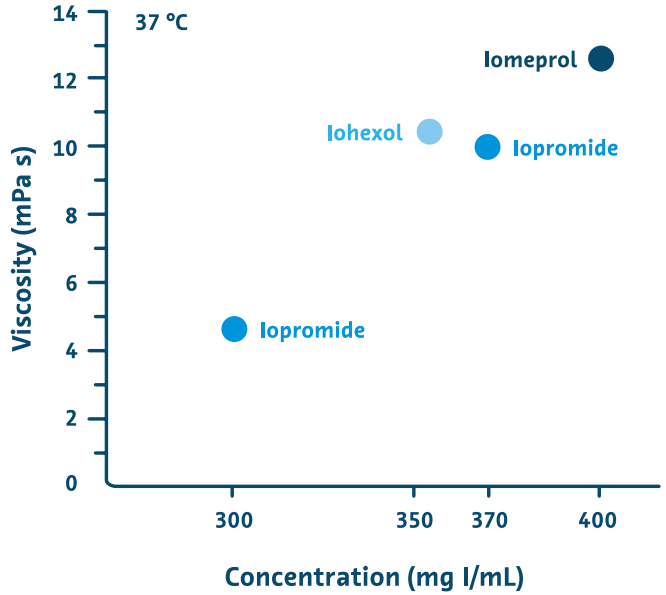
- Both Ultravist® 300 and 370 have a relatively low viscosity in relation to their iodine concentration which allows for lower peak pressures at identical flow rates.[1]
- Despite having a lower iodine concentration, the viscosity of Iohexol 350 is higher than that of Ultravist® (Iopromide) 370.*,[1]



Relation of CT-CON investigated contrast media concentrations to their viscosity at 37° Celsius as stated in the respective prescribing information [2-4]

* numerically, not statistically significant

1. Rengo M, et al. Impact of iodine concentration and iodine delivery rate on contrast enhancement in coronary CT angiography: a randomized multicenter trial (CT-CON). Eur Radiol. 2019 Nov;29(11):6109-6118. doi: 10.1007/s00330-019-06196-7
2. Iopromide prescribing information. http://www.mhra.gov.uk/spc-pil/?subsName=IOPROMIDE&pageID=SecondLevel. Date of access: December 2019.
3. Iomeprol prescribing information. https://imaging.bracco.com/sites/braccoimaging.com/files/technica_sheet_pdf/de-de-2018-11-15-spc-Imeron.pdf. Date of access: December 2019.
4. Iohexol prescribing information. https://www.accessdata.fda.gov/drugsatfda_docs/label/2018/018956s101lbl.pdf. Date of access: December 2019.

Concentration to Viscosity Ratio

- Concentration and viscosity are two properties of contrast media & its ratio is important for an evaluation of a contrast medium
- Hence, the concentration to viscosity ratio (CVR) has been proposed in the InnoVatE study,2020, as a new parameter
- This study assessed the impact of injection system technologies and CM viscosity on achievable iodine delivery rates and vascular enhancement.
- It concluded that- the tested piston-based injection systems (like Centargo) combined with low viscosity contrast media provide higher achievable IDRs and higher peak vascular enhancement than the tested peristaltic-based injectors.

$$\frac{\text{Concentration}\ [\text{mg I / mL}]}{\text{Viscosity}\ [\text{cP}]} = \text{CVR}\ [\text{mg I / mL / cP}]$$

McDermott M, Kemper C, Barone W, Jost G, Endrikat J. Impact of CT Injector Technology and Contrast Media Viscosity on Vascular Enhancement: Evaluation in a Circulation Phantom. Br J Radiol 2020; 93: 20190868.

Concentration to Viscosity Ratio

InnoVatE study measured the viscosity of iodinated contrast media at room temperature. In addition, viscosity as published by the respective manufacturer is also provided.

To calculate the CVR, the concentration e.g. 370 is divided by viscosity (UV 370= 17.10), leading to a CVR of 21.6

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****
Iopromide	300	9.2	7.64	39.3	61.2
Iodixanol	320	26.6	21.10	15.2	27.1
Iohexol	350	20.4	18.70	18.7	33.7
Iopromide	370	22.0	17.10	21.6	37.0
Iomeprol	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

McDermott M, Kemper C, Barone W, Jost G, Endrikat J. Impact of CT Injector Technology and Contrast Media Viscosity on Vascular Enhancement: Evaluation in a Circulation Phantom. Br J Radiol 2020; 93: 20190868.

General Safety

Ultravist® has a low prevalence of HSRs[1]

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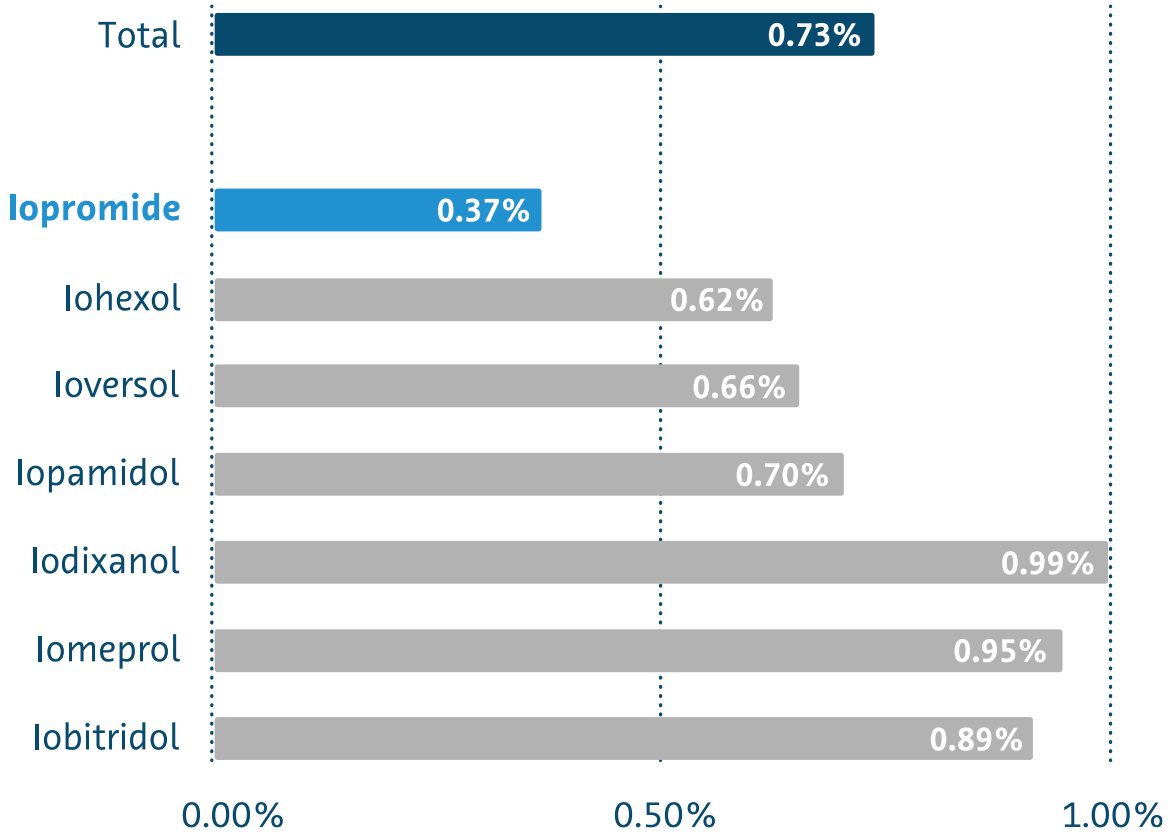
- A 2019 published Korean nationwide registry study, sponsored by the Ministry of Food and Drug Safety as a multi-center study (March 2017 and October 2017) from seven tertiary referral hospitals in Korea including 196,081 patients and seven ICM examined:[2]
  - Prevalence
  - Risk factors
  - And preventive measures for HSRs

Iopromide (Ultravist®) showed the lowest prevalence of HSRs in this study.



Prevalence of hypersensitivity reactions in the Korean Registry Study by Cha et al.[2]

1. Endrikat J et al. Risk of Hypersensitivity Reactions to Iopromide After Intra-Arterial Versus Intravenous Administration: A Nested Case-Control Analysis of 133,331 Patients. Invest Radiol. 2020 Jan;55(1):38-44. doi: 10.1097/RLI.0000000000000611.
2. Cha MJ, et al. Hypersensitivity Reactions to Iodinated Contrast Media: A Multicenter Study of 196 081 Patients. Radiology. 2019. Oct;293(1):117-124. doi:10.1148/radiol.2019190485

Choosing the right contrast agent

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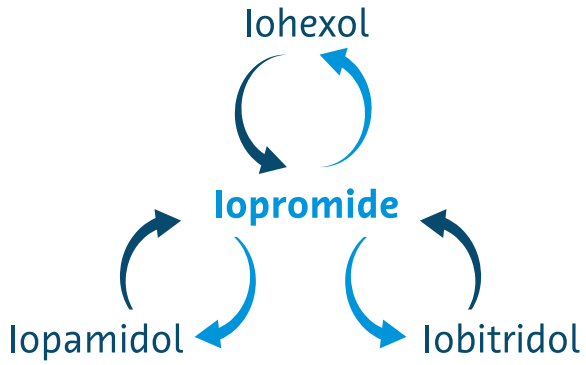
- Guidelines suggest that changing ICM is helpful to reduce HSR recurrence[1,2]
- In 2018 Park et al. evaluated different exchange combinations of ICM[3]:
  - It was concluded that the optimal choice could be individualized according to the culprit agent
  - Five favorable combinations of substitutes depending on culprit agent were identified
  - Ultravist® is suggested in 3 of these 5 pairs that showed a reduced risk for HSR recurrence[3]

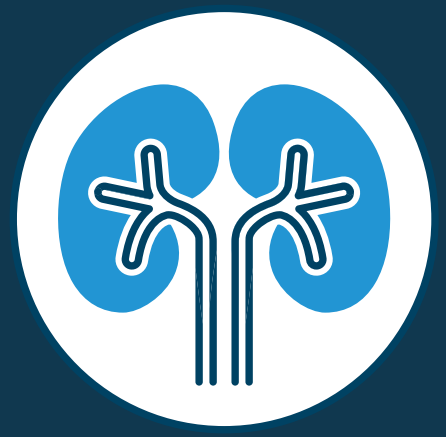


Combination of Contrast Media	Recurrence	Odds ratio*	95% Confidence Interval	P Value	Odds Ratio+	95% Confidence Interval	P Value
Iohexol / Iopamidol	24/110 (21.8)	0.470	0.247, 0.892	.021	1.863	0.995, 3.487	.052
Iopamidol / **Iopromide**	11/58 (19.0)	0.366	0.163, 0.820	.015	1.466	0.654, 3.289	.353
Iohexol /**Iopromide**	37/268 (13.8)	0.402	0.227, 0.712	.002	1.353	0.788, 2.321	.273
Iobitridol / Iohexol	32/261 (12.3)	0.245	0.127, 0.474	<.0001	0.887	0.468, 1.680	.713
Iobitridol / **Iopromide**	18/169 (10.7)	0.296	0.129, 0.682	.004	1.048	0.462, 2.374	.911
Iobitridol / Iopamidol	7/17 (41.2)	0.942	0.340, 2.608	.909	4.175	1.545, 11.281	.005
Iobitridol / Ioversol	7/21 (33.3)	0.890	0.321, 2.466	.823	3.310	1.210, 9.056	.020
Iopromide / Ioversol	1/2 (50.0)	1.344	0.083, 21.898	.835	5.961	0.369, 96.259	.208
Iohexol / Ioversol	5/12 (41.7)	0.876	0.237, 3.232	.842	3.585	0.978, 13.137	.054
Iohexol / Iomeprol	3/13 (23.1)	0.709	0.163, 3.084	.647	1.937	0.437, 8.591	.384
Iomeprol / Iopamidol	4/19 (21.1)	0.472	0.144, 1.551	.216	1.804	0.551, 5.913	.330
Iopamidol / Ioversol	2/10 (20.0)	0.188	0.023, 1.569	.123	0.779	0.094, 6.454	.817
Iomeprol / Iopromide	2/11 (18.2)	0.612	0.108, 3.451	.578	1.877	0.321, 10.980	.485
Iobitridol /Iomeprol	0/8 (0)	...	NA	...	...	NA	...
Iomeprol / Ioversol	0/1 (0)	...	NA	...	...	NA	...

* Compared with exposure to same CM.+ Compared with exposure to different CM.

HSR recurrence and odds ratios for different substitute combinations.[3]

1. ACR Committee on Drugs and Contrast Media -ACR Manual on Contrast Media. 2018; Version 10.3. Available at: https://www.acr.org/-/media/ACR/Files/Clinical-Resources/Contrast_Media.pdf.
2. European Society of Urogenital Radiology: ESUR Guidelines on Contrast Media (version 10.0) 2019: URL: http://www.esur.org/fileadmin/content/2019/ESUR_Guidelines_10.0_Final_Version.pdf
3. Park SJ, et al. Immediate Mild Reactions to CT with Iodinated Contrast Media: Strategy of Contrast Media Readministration without Corticosteroids. Radiology. 2018 Sep;288(3):710-716.doi: 10.1148/radiol.2018172524.



Renal Safety

Guideline recommendations regarding renal safety

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- Recommendations on the choice of iodinated contrast medium do not state a preference for IOCM over LOCM regarding renal safety.

Scientific Association	Recommendations
American College of Radiology (2020 update)[1]	"Studies have **failed to establish a clear advantage of IV iso-osmolality iodixanol over IV LOCM with regard to PC-AKI or CIN**. A 2009 meta-analysis (Heinrich et al.,2009) using data pooled from 25 trials found no difference in the rate of PC-AKI between iodixanol and low osmolality agents after intravenous administration ."
American College of Radiology and the National Kidney Foundation (2020)[2]	**"There are no clinically relevant differences in CI-AKI risk between iso-osmolality and low-osmolality iodinated contrast media ."**
ESUR Contrast Media Safety Committee (ESUR V10.0)[3]	For all patients use **low- or iso-osmolar contrast media**. Use the **lowest dose** of contrast medium consistent with a diagnostic result.
Canadian Association of Radiologist (Owen RJ et al. 2014)[4]	"Larger studies and meta-analyses revelead **no significant difference between iodixanol and most low-osmolar contrast media.** […] Currently, the Canadian Association of Radiologists recommends the **use of iso- or low-osmolar media in patients with GFR <45 mL/min** in intravenous administration and **GFR <60 ml/min at** intraarterial administration."
The Renal Association, British Cardiovascular and Intervention Society and The Royal College of Radiologists (2013 Update)[5]	"Currently there is only one type of iso-osmolar media which has **failed to demonstrate any clear benefit compared to different low-osmolar media in preventing CI-AKI**"
American College of Cardiology Foundation/Society for Cardiovascular Angiography and Interventions (Bashore TM et al. 2012)[6]	"[The volume of] contrast media should be minimized, **and low-osmolar or iso-osmolar contrast media should be used**"
European Society of Cardiology (2018 Update)[7]	"Use of low-osmolar or iso-osmolar contrast media is recommended for patients with moderate or severe CKD"

1. ACR Committee on Drugs and Contrast Media -ACR Manual on Contrast Media. Version 2020. Available at: https://www.acr.org/-/media/ACR/Files/Clinical-Resources/Contrast_Media.pdf
2. Davenport M., et al. Use of Intravenous Iodinated Contrast Media in Patients with Kidney Disease: Consensus Statements from the American College of Radiology and the National Kidney Foundation. Radiology 2020. 294:660–668. 10.1148/radiol.2019192094.
3. European Society of Urogenital Radiology: ESUR Guidelines on Contrast Media (version 10.0) 2019: URL: http://www.esur.org/fileadmin/content/2019/ESUR_Guidelines_10.0_Final_Version.pdf
4. Owen RJ, et al. Canadian Association of Radiologists consensus guidelines for the prevention of contrast-induced nephropathy: update 2012. Can Assoc Radiol J. 2014 May;65(2):96-105. doi: 10.1016/j.carj.2012.11.002
5. The Renal Association, British Cardiovascular Intervention Society and The Royal College of Radiologists, Prevention of Contrast Induced Acute Kidney Injury (CI-AKI) In Adult Patients
6. Bashore TM, et al. ACCF Task Force Members. 2012 American College of Cardiology Foundation/Society for Cardiovascular Angiography and Interventions expert consensus document on cardiac catheterization laboratory standards update: A report of the American College of Cardiology Foundation Task Force on Expert Consensus documents developed in collaboration with the Society of Thoracic Surgeons and Society for Vascular Medicine. J Am Coll Cardiol. 2012 Jun 12;59(24):2221-305. doi: 10.1016/j.jacc.2012.02.010
7. Neumann F.-J., et al., 2018 ESC/EACTS Guidelines on myocardial revascularization, European Heart Journal, 2019; 40, 87–165 doi:10.1093/eurheartj/ehy394

Viscosity level of contrast media significantly differs in different layers of the kidney

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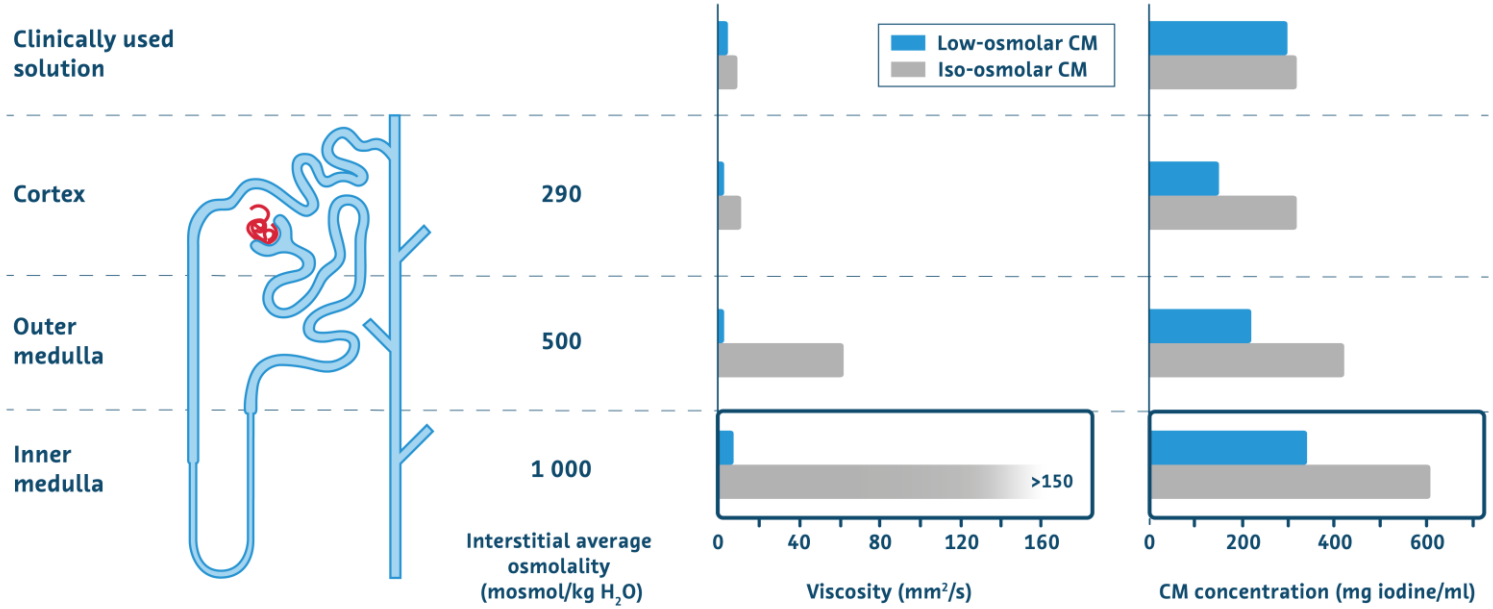

- At 1,000 mosmol/kg H_2O, the level of viscosity for IOCM markedly exceeds the maximum value which a viscometer can measure.
- In contrast, the viscosity level of LOCM only slightly increased compared to the initial solution.

- At 1,000 mosmol/kg H_2O, the concentration of low-osmolar CM is slightly elevated.
- In contrast, the concentration of iso-osmolar CM is about twice as high as that of the original solutions.

1. Fähling M et al. Understanding and preventing contrast-induced acute kidney injury. Nat Rev Nephrol 13, 169–180 (2017). https://doi.org/10.1038/nrneph.2016.196

Scientific and clinical evidence on renal safety

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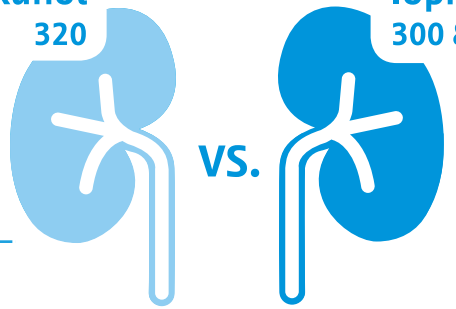
Iso-osmolar contrast media
Iodixanol 320



Low-osmolar contrast media
Iopromide 300 & 370

INDIVIDUAL COMPARISON IOPROMIDE VS. IODIXANOL*

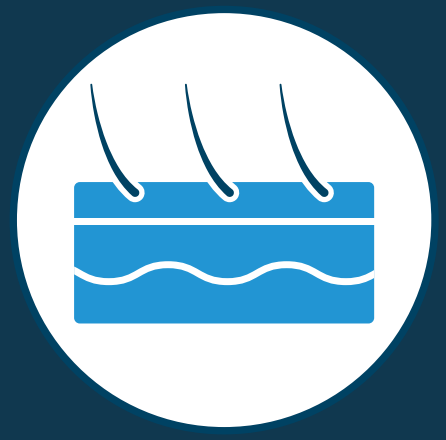
Chen et al. (2012)[1]	Iodixanol 320 (N=284) Iopromide (Ultravist®) 370 (N=278)	***NON-INFERIOR*** (p<0.001)
Bolognese et al. (2012)[2]	Iodixanol 320 (N=236) Iopromide (Ultravist®) 370 (N=239)	***NON-INFERIOR*** (p<0.0002)
Shin et al. (2011)[3]	Iodixanol 320 (N=215) Iopromide (Ultravist®) 300 (N=205)	***NO SIGNIFICANT DIFFERENCE*** (p=0.394)
Juergens et al. (2009)[4]	Iodixanol 320 (N=91) Iopromide (Ultravist®) 370 (N=100)	***NO SIGNIFICANT DIFFERENCE*** (p=0.56)

META-ANALYSES LOCM VS. IODIXANOL

Han et al. (2018)[5]	Diabetic patients, 12 trials Iodixanol 320 (N=575) LOCM (N=525)	***NO SIGNIFICANT DIFFERENCE*** Subgroup analysis: Significant difference between iohexol and iodixanol
From et al. (2010)[6]	36 trials Iodixanol 320 (N=3,672) LOCM (N=3,494)	***NO SIGNIFICANT DIFFERENCE*** Subgroup analysis: Significant difference between iohexol and iodixanol
Heinrich et al. (2009)[7]	25 trials Iodixanol (N=1,701) LOCM (N=1,569)	***NO SIGNIFICANT DIFFERENCE*** Subgroup analysis: Significant difference between iohexol and iodixanol

No significant difference in scientific and clinical evidence regarding **renal safety** between IOCM and LOCM.

1. Chen Y et al. Renal tolerability of iopromide and iodixanol in 562 renally impaired patients undergoing cardiac catheterisation: the DIRECT study.
2. Bolognese L, et al. Impact of iso-osmolar versus low-osmolar contrast agents on contrast-induced nephropathy and tissue reperfusion in unselected patients with ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. Am J Cardiol. 2012 Jan 1;109(1):67-74. doi: 10.1016/j.amjcard.2011.08.006
3. Shin DH, et. al. Comparison of contrast-induced nephrotoxicity of iodixanol and iopromide in patients with renal insufficiency undergoing coronary angiography. Am J Cardiol. 2011 Jul 15;108(2):189-94. doi: 10.1016/j.amjcard.2011.03.019
4. Juergens CP, et al. Nephrotoxic effects of iodixanol and iopromide in patients with abnormal renal function receiving N-acetylcysteine and hydration before coronary angiography and intervention: a randomized trial. Intern Med J. 2009 Jan;39(1):25-31. doi: 10.1111/j.1445-5994.2008.01675.x
5. Han XF, et al. Contrast-induced nephropathy in patients with diabetes mellitus between iso- and low-osmolar contrast media: A meta-analysis of full-text prospective, randomized controlled trials. PLoS One. 2018 Mar 20;13(3). doi: 10.1371/journal.pone.0194330
6. From AM, et al. Iodixanol versus low-osmolar contrast media for prevention of contrast induced nephropathy: meta-analysis of randomized, controlled trials. Circ Cardiovasc Interv. 2010 Aug;3(4):351-8. doi: 10.1161/CIRCINTERVENTIONS.109.917070
7. Heinrich MC, et al. Nephrotoxicity of iso-osmolar iodixanol compared with nonionic low-osmolar contrast media: meta-analysis of randomized controlled trials. Radiology. 2009; 250(1):68-86. doi: 10.1148/radiol.2501080833



Delayed Skin Reactions

Late Adverse Reactions -ICM

Definition: A late adverse reaction to intravascular ICM is defined as a reaction which occurs 1 h (30-60mins)[A] to 1 week after CM injection.[E]

- Majority occurring between 3 hours and 2 days[A]

ESUR (V.10.0) & ACR (V.11)	
Reactions[E]	▪ Skin reactions similar in type to other drug induced eruptions occur. - Maculopapular rashes, erythema, swelling and pruritus are most common. - Most skin reactions are mild to moderate and self-limiting. ▪ A variety of late symptoms (e.g., nausea, vomiting, headache, musculoskeletal pains, fever) have been described following CM, but many are not related to the CM.
Risk factors for skin reactions[E]	▪ Previous late CM reaction ▪ Interleukin-2 treatment ▪ Use of non-ionic dimers
Incidence[A]	▪ 0.5% to 14% (Delayed allergic-like reactions) ▪ A prospective study of 258 individuals receiving intravenous iohexol demonstrated a delayed reaction rate of **14.3%** compared to **2.5%** in a control group undergoing imaging without intravascular contrast material. (Loh et al., 2010)

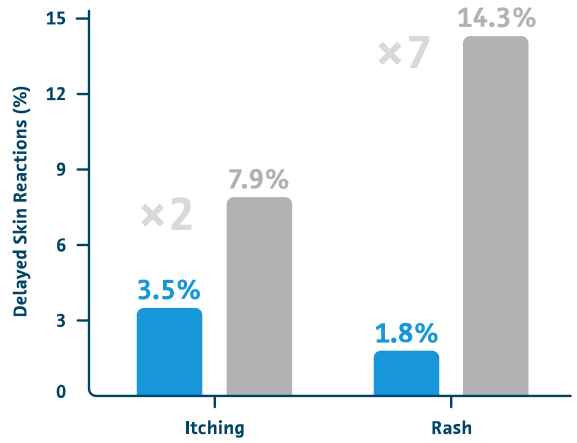
Note: Late skin reactions of the type which occur after ICM have not been described after GBCA and ultrasound contrast media.

ICM: iodine-based contrast media
GBCA: gadolinium-based contrast agent
CM: Contrast Medium

[E]ESUR Guidelines on Contrast Media Version 10.0; 2018
[A]ACR Manual on Contrast Media Version 11; 2020

Delayed skin reactions with LOCMs vs. IOCMs

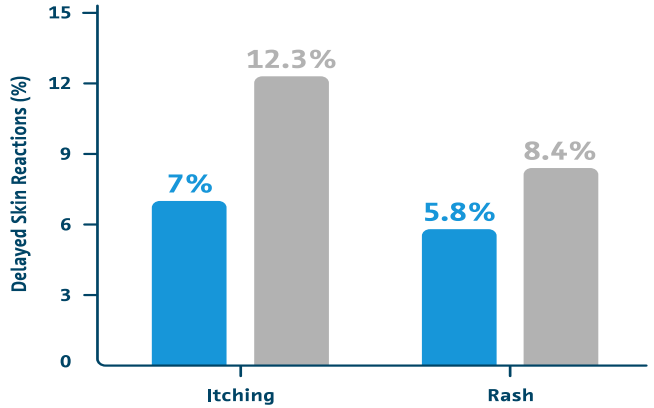
Ultravist® Iopromide



Iopamidol, Ioxaglate

Iodixanol

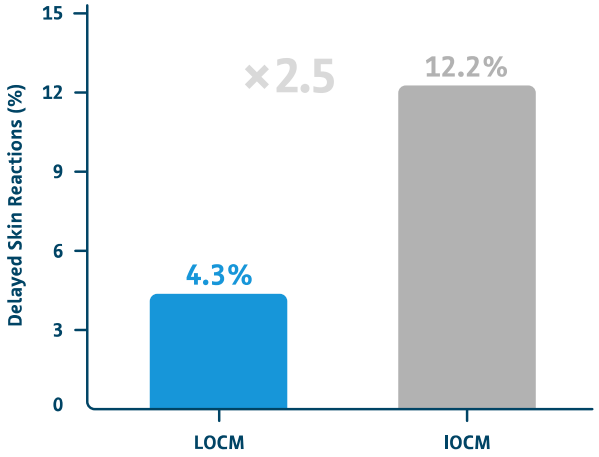
Delayed skin reactions are less frequent with LOCMs than with IOCMs.[1,2,3]



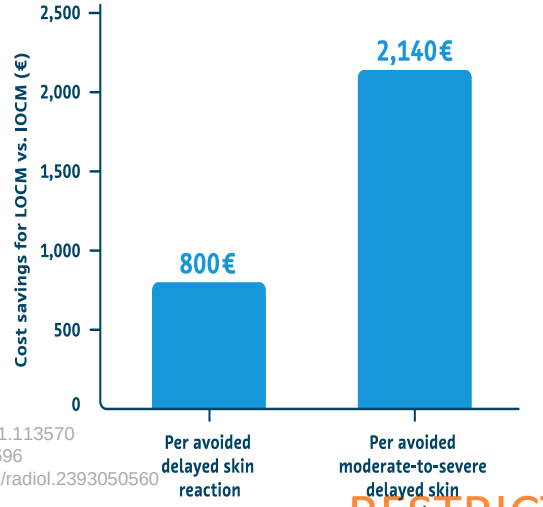
Ultravist® (Iopromide)

Iotrolan

Reactions to CM may cause additional costs such as concomitant medication, healthcare personnel or hospitalization [4]



LOCMs like Ultravist® have less additional costs due to delayed skin reactions than IOCMs [4]



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2. Gharekhanloo F and Torabian S, Comparison of allergic adverse effects and contrast enhancement between iodixanol and iopromide. Iran J Radiol. 2012;9(2):63-66. doi: 10.5812/iranjradiol.7696
3. Schild HH, et al. Adverse events after unenhanced and monomeric and dimeric contrast-enhanced CT: a prospective randomized controlled trial. Radiology 2006; 240(1): 56 – 64. doi: 10.1148/radiol.2393050560
4. Arana E and Catalá-López F, Cost-effectiveness of iodinated contrast media for CT scanning in Spain: A decision-based analysis. Imaging Med. 2012 4(2), 193–99

Clinical Updates on ACR 2021 Guidelines

ACR 2021 Guidelines Update Summary

Changes	Details
Addition of Chapter 5- Fasting Prior to Intravascular Contrast Media Administration	• Given the potential for negative consequences due to fasting and a lack of evidence that supports the need for fasting, fasting is not required prior to routine intravascular contrast material administration. • However, for patients receiving conscious sedation, anesthesia guidelines should be consulted
Chapter 10- Change in terminologies	Post-contrast acute kidney injury (PCAKI) **IS NOW** Contrast-associated acute kidney injury (CA-AKI) Contrast-induced nephropathy (CIN) **IS NOW** Contrast-induced acute kidney injury (CI-AKI)
Chapter 10- Volume Expansion protocol recommendations to prevent CA-AKI made more concrete	• Isotonic fluid such as 0.9% normal saline (NS) is preferred. • Typical prophylaxis regiments begin 1 hour prior to the exam and continue 3-12 hours after. Typical doses may be fixed volume (e.g., 500 mL NS) before and after or weight-based volumes (1-3mL/kg per hour) • The ideal infusion rate and volume is unknown
Chapter 10- Addition of Indications & Contraindications for volume expansion to prevent CA-AKI	**Indications-** • Patients who have AKI or severe CKD with an eGFR less than 30 mL/min/1.73m2, although the risks of volume expansion (i.e., heart failure or other hypervolemic conditions) should be considered before initiation. • Considered on an individual basis for high-risk circumstances (e.g., numerous risk factors, recent AKI, borderline eGFR) in patients with an eGFR of 30-44 mL/min./1.73 m2 at the discretion of the ordering provider **Contraindication-** • General population of patients with stable eGFR greater than or equal to 30 mL/min 1.73 m2 or patients on chronic dialysis.

CM: Contrast Medium
CT: Computed Tomography
MRI: Magnetic resonance Imaging
LOCM: Low Osmolar Contrast Medium
IOCM: Iso Osmolar Contrast medium

ACR 2021 Guidelines Update Summary contd……

Changes	Details
Changes in Chapter 10- Use of N-acetylcysteine & Sodium Bicarbonate for prevention of CA-AKI	• Recent randomized trial showed that N-acetylcysteine was no more effective than placebo at preventing CA-AKI for intra-arterial iodinated contrast media administration and is therefore not recommended for intravenous contrast media prophylaxis • Bicarbonate is likely similar to normal saline for the prevention of CA-AKI, but it is not preferred due to the additional requirement for pharmacist compounding.
Renal Dialysis Patients and the Use of Iodinated Contrast Medium	• Patients undergoing dialysis who make more than 1-2 cups of urine/day (100 mL) should be considered nonanuric and treated as high-risk patients similar to patients with AKI or eGFR less than 30 mL/min/1.73m2 who are not undergoing hemodialysis. • Patients should not have acute dialysis nor continuous renal replacement therapy initiated or alter their schedule solely based on iodinated contrast media administration regardless of renal function due to the risks, costs and lack of benefit .
Chapter 16- NSF- Identifying patients at-risk of NSF	• Addition of- History of CKD or prior history of AKI to the list • Removal of- History of hypertension requiring medical therapy from the list • Changed to Optional- History of diabetes mellitus
Chapter 16- Calculating eGFR	• Methods of calculating eGFR are in flux as efforts are underway to remove race from clinical calculators.
Chapter 16- Changes made to Additional Specific Recommendations for Specific Groups of Patients- Patients with end-stage renal disease on chronic dialysis	• The ACR & NKF recommend that in patients who are already receiving dialysis, if feasible, elective GBCA-enhanced MRI examinations be performed before regularly scheduled dialysis. • Due to the risks of catheter placement and infection, the possibility of worsening kidney function in patients with AKI and CKD, and the perceived very low risk of NSF from group II and III GBCM agents, dialysis should not be initiated or altered in patients receiving a group II GBCM

CM: Contrast Medium; CT: Computed Tomography; MRI: Magnetic resonance Imaging;LOCM: Low Osmolar Contrast Medium; IOCM: Iso Osmolar Contrast medium

An exciting opportunity to share rare & interesting cases from your practice!!!

Clinical Case Series of Contrast-Enhanced CT Using Iopromide

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Takashi Oba[1], RT

[1]Department of Radiology, Hamamatsu University School of Medicine

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Overview

(1) Role of contrast-enhanced CT for abdominal diseases (especially for hepato-biliary-pancreatic diseases) and the concept of protocol setting

In any hepato-biliary-pancreatic disease, hemodynamic information obtained by multi-phase imaging is essential for the detection of primary lesions, qualitative diagnosis, staging, evaluation of therapeutic response, and screening for postoperative complications.[1] Most patients with malignant tumors may be followed-up on even after adequate treatment, generally using contrast-enhanced CT obtained in portal venous phase.

Although MRI using Gd-EOB-DTPA is recommended to detect primary and metastatic liver cancer,[2] contrast-enhanced CT is still frequently used in the clinical setting because of several problems including the lower throughput of MRI examinations.

Qualitative diagnosis of hepatocellular carcinoma (HCC) could be achieved on the basis of early enhancement of the lesion in the hepatic arterial phase followed by washout and capsule enhancement in the portal venous or equilibrium phase. Thus, the optimization of hepatic arterial phase is crucial for the diagnosis of hypervascular HCC and even for hypovascular HCC which will be treated when the lesion obtains internal hypervascularization. Regarding the selection of treatment for HCC, it is important to clarify the relationship between the target lesion and the hepatic vascular structures, especially for local treatments including local excision, radiofrequency ablation, and transcatheter arterial embolization.

Regarding cancers of the gallbladder, bile duct, and pancreas, their enhancement patterns are widely varied depending on the ratio of cancer cells and desmoplastic fibrous tissues within the tumor. The lesion often appears in a state of hyperenhancement in the hepatic arterial phase when the cancer cell component is relatively rich, whereas the lesion demonstrates delayed enhancement in the equilibrium phase when the interstitial fibrous tissue component is rich. In this situation, contrast-enhanced CT images obtained in both the portal venous and equilibrium phase are required to determine the extent of resection and to check the liver metastases. Due to the limited detectability of contrast-enhanced CT imaging for liver metastases, it is strongly recommended to add Gd-EOB-DTPA-enhanced MRI if optimized contrast-enhanced CT imaging detects doubtful lesions for metastases.

(2) Characteristics of the technology applied to the CT system used in our cases

Revolution CT (GE Healthcare) used in our cases is equipped with 0.625 mm × 256 detectors. It has a garnet scintillator and a high-performance generator with an emission sensitivity 100 times higher than those of conventional detectors. Furthermore, a high-performance 2D collimator was used to efficiently remove scattered radiation. Therefore, the system provides extremely high image quality and high accuracy in quantification using dual energy CT imaging with ultrafast kV switching at 0.25 msec rotation speed. In addition, the on-board GSI Xtream Smart Workflow enables simultaneous parallel processing even in scanning, which does not affect any interference with routine dual-energy CT imaging. Revolution CT can also be applied as an area detector CT and has been used for perfusion analysis and 4D-DSA in clinical practice. In combination with such excellent basic performance, the newly introduced deep learning-based image reconstruction technology enables excellent reduction of image noise even in dual-energy and low-tube-voltage CT imaging. These reasons are why this system has been gradually gaining attention in the clinical setting.

[1]the Japanese Imaging Guideline 2019, Japan Radiological Society, 2019, Kanehara-shuppan

[2]the clinical cases, images, interpretation and diagnosis are provided through the courtesy of Hamamatsu University, Japan

Imaging Protocol

CT system / model name	Revolution CT (GE Healthcare, Japan)		
Detector area	256 rows/rotation		
Workstation / software name	AW server / GE Healthcare, Japan); SYNAPSE VINCENT / FUJIFILM Medical Co., Ltd.		
Automatic injector / manufacturer	Dual Shot GX7 / Nemoto Kyorindo Co., Ltd.	Saline flush rate	3 mL/s
Contrast medium	Iopromide 370 Injection 注射液	Injection parameter	30 kg/cm²

Cases 1 to 3 (hepatic, biliary, and pancreatic contrast CT imaging)

Contrast dose	600 mgI/kg	Saline dose	40 mL	Scan timing	ROI method (aortic artery) / 80 HU
Contrast injection time	40 sec	Saline injection rate	Same as the contrast injection rate	Delay time	Test bolus scan

Imaging phase	Early arterial phase	Late arterial phase	Early portal phase	Portal phase	Equilibrium phase	Plain CT
Tube voltage (kV)	120 (80-140)	120 (80-140)	120 (80-140)	120 (80-140)	120 (80-140)	100
AEC	120 Fixed	120 Fixed	120 Fixed	120 Fixed	120 Fixed	Smart mA
Detector width (mm)	80	80	80	80	80	80
Rotation time (sec)	0.5	0.5	0.5	0.5	0.5	0.5
Scan FOV	Large	Large	Large	Large	Large	Large
Scan type	Helical	Helical	Helical	Helical	Helical	Helical
Pitch	0.984	0.984	0.984	0.984	0.984	0.984
Scan range	Upper abdomen	Upper abdomen	Upper abdomen	From upper abdomen to pelvis	Upper abdomen	Upper abdomen
Scan time (sec)	6.01	6.01	6.01	6.01	6.01	3.73
Scan direction	Head to foot	Head to foot	Head to foot	Head to foot	Head to foot	Head to foot
Dose (Dose)	4 (low-kilovoltage) / 3 (standard) / 2 (high-kilovoltage)	3.5/3.5	3.5/3.5	3.5/3.5	3.5/3.5	-
	Filtered back-projection method	Hybrid IR-III M	Hybrid IR-III M	Hybrid IR-III M	Hybrid IR-III M	-
SD (HU)	4 (low-kilovoltage) / 3 (standard) / 2 (high-kilovoltage)	3.0/3.0	3.0/3.0	3.0/3.0	3.0/3.0	-
	Filtered back-projection method	Hybrid IR-III M	Hybrid IR-III M	Hybrid IR-III M	Hybrid IR-III M	-
Contrast start delay						
Delay time (sec)	10	10	10	10	100	-

Case 4 (head vascular)

Contrast dose	45 mL	Saline dose	30 mL	Scan timing	Test bolus, monitored, 10 mL, physiological saline, 10 mL
Contrast injection rate	3.0 mL/sec	Saline injection rate	3.0 mL/sec	Delay time	Test bolus, 5 sec or less scan

Imaging phase	Arterial phase	Venous phase	Equilibrium phase
Tube voltage (kV)	120	120	120 (80-140)
AEC	Manual	Manual	120 Fixed
Tube current (mA)	60	150	200
Rotation time (sec)	1.0	1.0	1.0
Detector width (mm)	0.625	0.625	2.5
Focal point size	Small	Small	Large
Scan range	Volume	Volume	Helical
Scan time (sec)	11.6	18.4	6.46
Scan direction	Head to foot	Head to foot	Head to foot
Dose (Dose)	4 (low-kilovoltage) / 3 (standard) / 2 (high-kilovoltage)	0.625/0.625	0.625/0.625	2.5/2.5
	Filtered back-projection method	Hybrid IR-III H	Hybrid IR-III H	Hybrid IR-III H VOLPAL

Case 1

A Case of Hepatocellular Carcinoma (HCC). Hemodynamic Assessment After the Introduction of Atezolizumab and Bevacizumab.

Contrast medium / dose used
Iopromide 370 / 60 mL

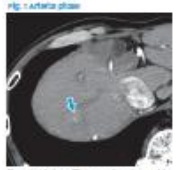
Patient background

Pathology	HCC
Age, gender, weight	70s, male, 57 kg
Examination purpose	The patient had a history of partial hepatectomy, TACE, radiation therapy, and treatment with lenvatinib for HCCs with underlying chronic hepatitis B. A cancer immunotherapy (atezolizumab and bevacizumab) was introduced for lesions that had rapidly progressed after the previous TACE. One week after the introduction, hepatic dynamic contrast-enhanced CT was performed for the hemodynamic assessment of treated HCCs.

Case Interpretation

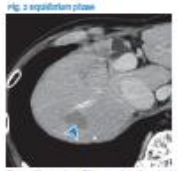
The combination therapy of atezolizumab and bevacizumab was approved in September 2020 in Japan as the first immunotherapy for unresectable HCCs. This patient showed multiple hypervascular HCC lesions on CT images before the introduction of immunotherapy. Just one week after the immunotherapy, arterial blood flow within the HCCs markedly decreased and was only sustained in the limited lesions (Figs. 1, 3, and 5; arrows). Dynamic contrast-enhanced CT using Iopromide clearly differentiated lesions with residual vascularity from those without any vascularity.

fig. 1 arterial phase



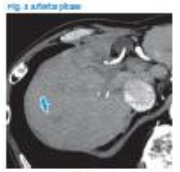
The arterial phase CT image showed a nodular enhancement (→) in the liver that became hypodense in the equilibrium phase, which is suggestive of a residual tumor.

fig. 2 equilibrium phase



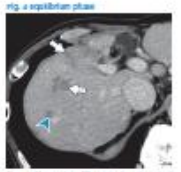
The equilibrium phase CT image showed washout (→) in the entire HCC, confirming the nodular enhancement on the arterial phase.

fig. 3 arterial phase



The arterial phase CT image showed a nodular enhancement (→) in the liver that became hypodense in the equilibrium phase, which is suggestive of a residual tumor.

fig. 4 equilibrium phase

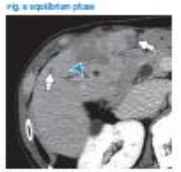


The equilibrium phase CT image showed washout (→) in the entire HCC, confirming the nodular enhancement in the arterial phase. The washout was also demonstrated in the small residual hyper-enhancement in the arterial phase, which is suggestive of a lesion without viable tumor cells.

fig. 5 arterial phase

The arterial phase CT image showed a nodular enhancement (→) in the liver that became hypodense in the equilibrium phase, which is suggestive of a residual tumor.

fig. 6 equilibrium phase



The equilibrium phase CT image showed washout (→) in the entire HCC, confirming the nodular enhancement in the arterial phase. The washout was also demonstrated in the small residual hyper-enhancement in the arterial phase, which is suggestive of a lesion without viable tumor cells.

Case 2

A Case of Perihilar Cholangiocarcinoma. Dynamic Contrast-Enhanced CT Assessment of the Tumor Extension.

Contrast medium / dose used
Iopromide 370 / 77 mL

Patient background

Pathology	Perihilar cholangiocarcinoma
Age, gender, weight	70s, male, 48 kg
Examination purpose	The patient, who had obstructive jaundice due to suspicious perihilar cholangiocarcinoma, underwent dynamic contrast-enhanced CT for preoperative assessment.

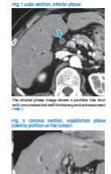
Case Interpretation

Accurate assessment of the horizontal tumor extension along the bile duct wall is crucial in deciding an appropriate surgical procedure for perihilar cholangiocarcinoma. In this case, thickened bile duct wall extended in the duodenal side but was limited at bilateral hepatic ducts in the hepatic side. Therefore, right hepatic lobectomy, resection of the extrahepatic bile duct, and choledochectomy were performed. Histopathologic examination confirmed negative margins.

Generally, cholangiocarcinoma has abundant fibrous components within the tumor and demonstrates the characteristic delayed enhancement on CT images. Therefore, the equilibrium-phase images are useful for the evaluation of tumor extent, in addition to thin slice and multi-planar reconstruction images.

Imaging findings

fig. 1 axial section, arterial phase

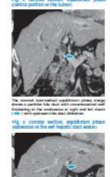


The arterial phase image shows a perihilar bile duct wall enhancement and thickening (arrowhead).

fig. 2 axial section, equilibrium phase

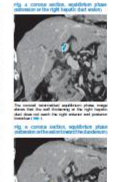
The equilibrium phase image shows a perihilar bile duct wall (arrow) contrast enhancement (arrowhead).

fig. 3 coronal section, equilibrium phase (optimal portion of the tumor)



The coronal reformatted equilibrium phase image shows that the wall thickening of the bile duct does not reach the right anterior and posterior bile duct walls.

fig. 4 coronal section, equilibrium phase (optimal portion of the left hepatic duct wall)

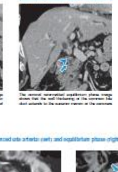


The coronal reformatted equilibrium phase image shows that the wall thickening of the left hepatic duct does not reach the hilar side of the umbilical portion.

fig. 5 coronal section, equilibrium phase (obliquely cut to the left hepatic duct wall)

The coronal reformatted equilibrium phase image shows that the wall thickening of the left hepatic duct does not reach the hilar side of the umbilical portion.

fig. 6 coronal section, equilibrium phase (obliquely cut to the cystic duct)



The coronal reformatted equilibrium phase image shows that the wall thickening of the common bile duct extends to the posterior margin of the common bile duct.

Case 3

A Case of Pancreatic Head Cancer with Typical Findings on Dynamic Contrast-Enhanced CT.

Contrast medium / dose used
Iopromide 370 / 92 mL

Patient background

Disease name	Pancreatic head cancer
Age, gender, weight	70s, male, 54.8 kg
Examination purpose	The patient visited a private clinic with subjective deep-yellow urine, and was then referred to our hospital due to suspected obstructive jaundice. Abdominal ultrasonography showed a pancreatic head mass and intrahepatic bile duct dilatation. The patient then underwent the extensive contrast-enhanced CT.

Case Interpretation

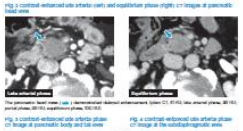
Contrast-enhanced CT demonstrated a hypovascular mass in the pancreatic head with coexisting main pancreatic duct dilatation and pancreatic parenchymal shrinkage in the body and tail. The pancreatic head mass demonstrated prolonged delayed enhancement on dynamic contrast-enhanced CT consistent with pancreatic ductal adenocarcinoma. In addition to the intrahepatic bile duct dilatation, heterogeneous and patchy enhancement was observed in the hepatic parenchyma which was suspicious due to intrahepatic cholangitis. An early enhancing arterio-portal shunting-like enhancement was also detected in segment VI, and subsequent contrast-enhanced MRI revealed a corresponding liver metastasis. A biliary drainage followed by systemic chemotherapy were scheduled.

Imaging findings

fig. 1 contrast-enhanced cine arterial phase CT image at the pancreatic head area

The contrast-enhanced cine arterial phase CT image showed a hypovascular mass (1 cm) in the pancreatic head (→fig. 1).

fig. 2 contrast-enhanced cine arterial phase (early and equilibrium phase (right)) CT images at pancreatic head area



The pancreatic head mass (→fig. 1) demonstrated delayed enhancement (plain CT, 37 HU; late arterial phase, 80 HU; portal phase, 88 HU; equilibrium phase, 100 HU).

fig. 3 contrast-enhanced cine arterial phase CT image at pancreatic body and tail area

The contrast-enhanced late arterial phase CT image demonstrated 'dilatation' main pancreatic duct and pancreatic parenchymal shrinkage in the body and tail of the pancreas (→fig. 3).

fig. 4 contrast-enhanced cine arterial phase CT image at the subdiaphragmatic area

The contrast-enhanced late arterial phase CT image demonstrated a 'dilatation' intrahepatic bile duct and 'heterogeneous' enhancement in the hepatic parenchyma, which was suspicious due to intrahepatic cholangitis.

fig. 5 contrast-enhanced cine arterial phase CT image at pancreatic head area

For early enhancing area was observed in segment VI (→fig. 6; subsequent contrast enhanced MRI revealed liver metastasis in a corresponding area).

Case 4

A Case of Pre-embolization Planning by 4D-CT for Hypervascular Skin Tumor on Scalp.

Contrast medium / dose used
Iopromide 370 / 45 mL

Patient background

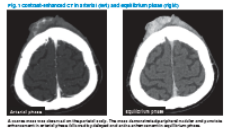
Disease name	Angiosarcoma of the scalp
Age, gender, weight	60s, male, 54.6 kg
Examination purpose	Chemoradiotherapy followed by systemic chemotherapy were performed for angiosarcoma of the scalp. Tumor resection was planned for persistent tumor growth and bleeding. Since the tumor was hypervascular and considered as high-risk for intraoperative bleeding, preoperative vascular embolization was planned. 4D-contrast-enhanced CT was performed to evaluate the feeding vessels and vascular anatomy of the tumor before embolization.

Case Interpretation

A hypervascular tumor was observed in the parietal scalp. Nodular and punctate enhancement was observed in the periphery of the tumor on contrast-enhanced arterial phase CT and gradually expanded within the tumor over time. Since the tumor was in the parietal region, bilateral superficial temporal arteries were suspected as feeding vessels through static CT. On the other hand, 4D-CT demonstrated the right superficial temporal artery as the main and sole feeding vessel. Digital subtraction angiography demonstrated the same findings as 4D-CT. Therefore, 4D-CT was considered to be useful for evaluating blood flow before endovascular treatment. The tumor was resected on the day after embolization, with only a limited amount of intraoperative bleeding.

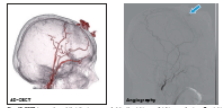
Imaging findings

fig. 1 contrast-enhanced CT in arterial (left) and equilibrium phase (right)



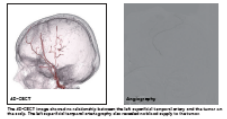
A coarse mass was observed on the parietal scalp. The mass demonstrated peripheral nodular and punctate enhancement in arterial phase (→fig. 1) and uniform enhancement in equilibrium phase.

fig. 2 a. right lateral view 4D-CT image (left) and b. right external carotid arteriography (right)



The 4D-CT image showed that the tumor was fed by the right superficial temporal artery. The right external carotid arteriography also demonstrated tumor enhancement (→fig. 2).

fig. 3 a. left lateral view 4D-CT image (left) and b. left external carotid arteriography (right).



The 4D-CT image showed no collaterals between the left superficial temporal artery and the tumor on the scalp. The left internal carotid arteriography also revealed no blood supply to the tumor.

Abbreviated Product Information - Ultravist

Ultravist® (iopromide) Prescribing Information (Refer to package insert before prescribing) **Presentation:** Intravascular injections of nonionic iopromide in strengths of 300mg and 370mg of iodine/ml. Intravascular injections of nonionic iopromide in strengths of 300mg and 370mg of iodine/ml. Indications: For diagnostic use only. Delineation of the vascular and renal systems and of body cavities **Posology and administration:** Adults Intravenous urography: minimum doses: Ultravist 370: 0.8ml/kg body weight; Ultravist 300: 1ml/kg body weight. Children **Intravenous urography:** see package insert. **Adults Computed tomography:** Cranial CT: Ultravist 300: 1-max, 2ml/kg body weight; Ultravist 370:1-max, 1.5ml/kg body weight. Whole-body CT: Dosage and administration rate depend on investigation and scanner. **Adults Angiography:** depends on age, weight, cardiac output, general condition, clinical problem, examination technique and the nature and volume of the vascular region to be investigated. (see package insert). **Paediatric population:** young infants (age < 1 year) and especially newborns are susceptible to electrolyte imbalance and haemodynamic alterations. Care should be taken regarding the dose of contrast medium to be given, the technical performancof the radiologicalprocedure and the patient status. **Renal impairment:** to reduce the risk of additional contrast media-induced renal impairment in patients with pre-existing renal impairment, the minimum possible dose should be used (see package insert). **Hepatic impairment:** no dosage adjustment is necessary. **Elderly:** possibility of reduced renal function should be considered. **Contra-indications:** Uncontrolled thyrotoxicosis. **Warnings and precautions:** Can be associated with anaphylactoid/hypersensitivity reactions, ensure preparedness for institution of emergency measures. Allergy-like reactions from mild to severe possible, mostly within 30 min, but delayed reactions (hours to days) may occur. Particularly careful risk/benefit judgement required for patients with: known hypersensitivity to Ultravist or its excipients; previous reaction to any contrast medium or; history of bronchial asthma or allergic disorders (increased risk). Pre-medicate with corticosteroids if necessary. To minimise risk: administer Ultravist to recumbent patients; observe patients closely for 15 minutes and keep them in hospital for at least one hour after the last injection. Patients on beta-blockers may be resistant to the effects of beta agonists. If severe reaction occurs, patients withcardiovascular disease are more susceptible to serious or fatal outcomes. Caution in patients with: known/suspected hyperthyroidism or goitre, monitor thyroid function in neonates exposed via mother or during neonatal period. Caution in patients with cerebral arteriosclerosis, pulmonary emphysema, poor general health, renal insufficiency, dehydration, diabetes mellitus, multiple myeloma/ paraproteinaemia, repetitive and/ or large doses of Ultravist. Nephrotoxicity may occur or rarely acute renal failure. Ensure adequate hydration of patients; correct water or electrolyte imbalances before administration. With cardiac or severe coronary artery disease, increased risk of haemodynamic changes or arrhythmia. Intravascular injection may precipitate pulmonary oedema in patients with heart failure. Increased risk of neurological complications in patients with seizure historyor CNS disorders. Caution in patients with reduced seizure threshold. May aggravate the symptoms of myasthenia gravis. Flush intravascular catheters frequently with physiological saline (if possible with addition of heparin) and minimise procedure length to minimise procedure-related thromboembolism risk. Patients with phaeochromocytoma may be at increased risk of developing a hypertensive crisis. Minimise excitement, anxiety and pain. Do not use in myelography. Sensitivity testing is not recommended. **Interactions:** Consider interruption of biguanides treatment prior to Ultravist administration as a precaution against development of lactic acidosis. Prevalence of delayed reactions higher in patients who have received interleukin-2. Diagnosis and treatment of thyroid disorders with thyrotropic radioisotopes may be impeded for up to several weeks due to reduced radioisotope uptake. Pregnancy and lactation: Adequate and well-controlled studies in pregnant women have not been conducted. Safety for nursed infants has not been investigated. **Effects on ability to drive and use machines:** Driving or operating machinery is not advisable for 30 minutes after the last injection. **Undesirable effects:** Common: dizziness, headache, dysgeusia, blurred/disturbed vision, chest pain/ discomfort, hypertension, vasodilatation, vomiting, nausea, pain, injection site reactions (e.g. oedema, soft tissue injury post extravasation), feeling hot. Uncommon: Hypersensitivity/anaphylactoid reactions (anaphylactoid shock, respiratory arrest, bronchospasm, laryngeal/pharyngeal/face oedema, tongue oedema, laryngeal/pharyngeal spasm, asthma, conjunctivitis, lacrimation, sneezing, cough, mucosal oedema, rhinitis, hoarseness, throat irritation, urticaria, pruritus, angioedema), vasovagal reactions, confusional state, restlessness, paraesthesia/ hypoaesthesia, somnolence, arrhythmia, hypotension, dyspnea, abdominal pain,oedema. Rare: Anxiety, cardiac arrest, myocardial ischemia, palpitations. Frequency not known: Thyrotoxic crisis, thyroid disorder, coma, cerebral ischaemia/infarction, stroke, brain oedemaa, convulsion, transient cortical blindness, loss of consciousness, agitation, amnesia, tremor, speech disorders, paresis/paralysis, hearing disorders, myocardial infarction, cardiac failure, bradycardia, tachycardia, cyanosis, shock, thromboembolic events,vasospasm, pulmonary edema, respiratory insufficiency, aspiration, dysphagia, salivary gland enlargement, diarrhoea, bullous conditions (e.g. Stevens-Johnson's or Lyell syndrome), rash, erythema, hyperhydrosis, compartment syndrome in case of extravasation, renal impairment, acute renal failure, malaise, chills, pallor, body temperature fluctuation. *These adverse reactions may have a fatal or life-threatening outcome and are considered the most serious adverse drug reactions. Prescribers should consult the SmPC in relation to other side effects. **Overdose:** Symptoms may include fluid and electrolyte imbalance, renal failure, cardivascular and pulmonary complications. Monitoring of fluids, electrolytes and renal function recommended in case of intravascular overdosage. Treatment of overdose should be directed towards the support of vital functions. Ultravist is dialysable. **Incompatibilities:** Because of possible precipitation, X-ray contrast media and prophylactic agents must not be injected as mixed solutions. **Special Precautions for Storage**: Protect from light and X-rays. **Date of revision of text:** April 2017. Please note: for current prescribing information refer to the package insert and/or contact your local Bayer HealthCare organization. **Bayer HealthCare Ltd**.14th Floor, Oxford House, Taikoo Place, 979 King's Road, Quarry Bay, Hong Kong.

THANK YOU!

Polling Question:

What do scientific associations like American College of Radiology(ACR), NKF(National Kidney Foundation), and likewise, recommend on the choice of iodinated contrast medium between Low Osmolar Contrast Medium (LOCM) and Isosmolar Contrast Medium(IOCM), regarding renal safety.

A. The LOCMs are better than IOCM

B. There are no clinically relevant differences in CI-AKI risk between iso-osmolality and low-osmolality iodinated contrast media

C. The IOCM is better than LOCMs

D. None of the above