Liver MRI:
Hepatobiliary contrast agents

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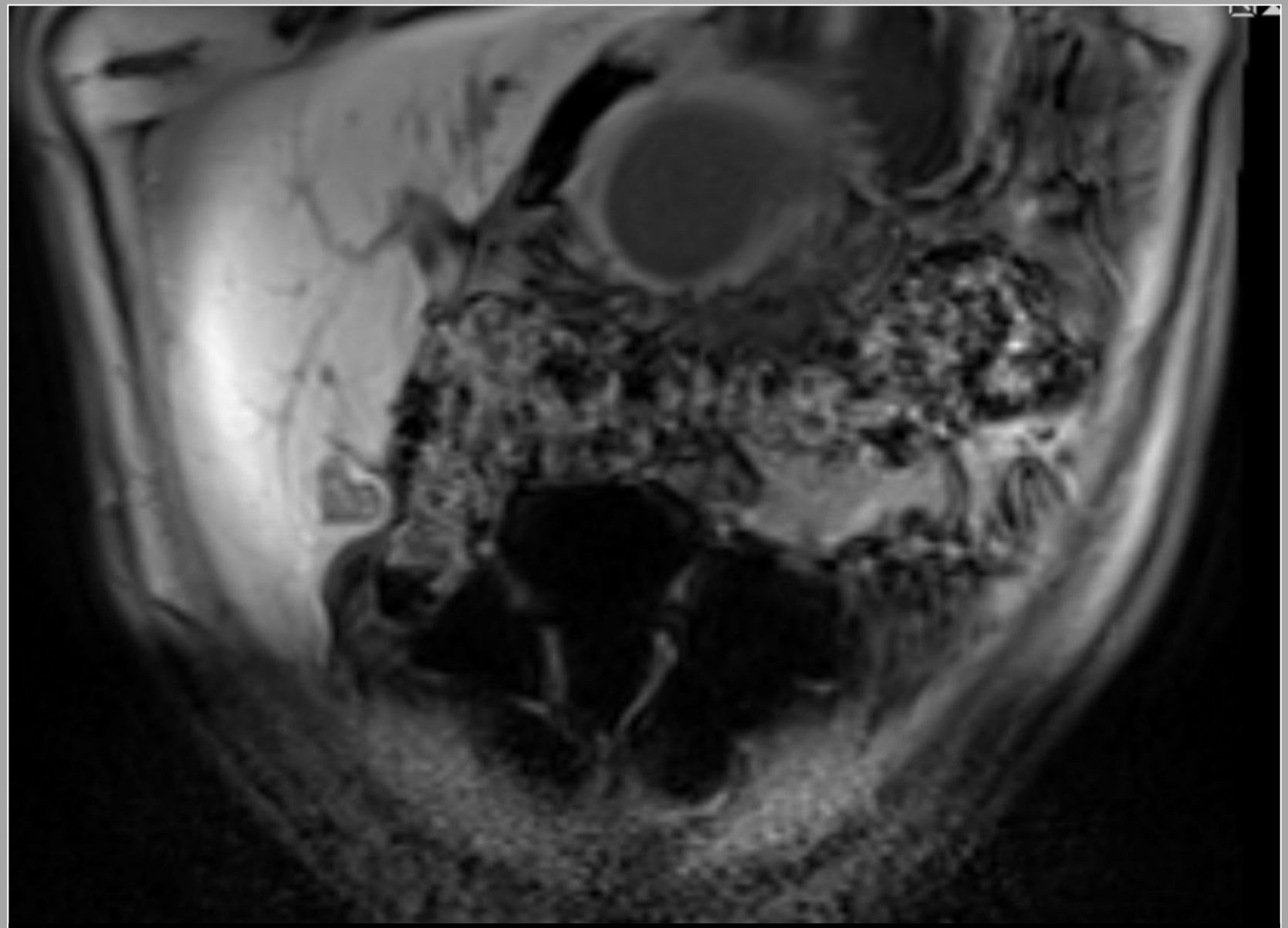
Disclosures

- Institutional consultation fees: Bayer, Ascelia Pharma, Guerbet

Learning objectives

- To learn the mechanism of action of liver-specific contrast agents (LS-CA)
- To get acquainted with the added value of LS-CA in the characterization of focal liver lesions
- To understand the most common pitfalls and limitations of LS-CA



Coronal T1-weighted MRI in hepatobiliary phase

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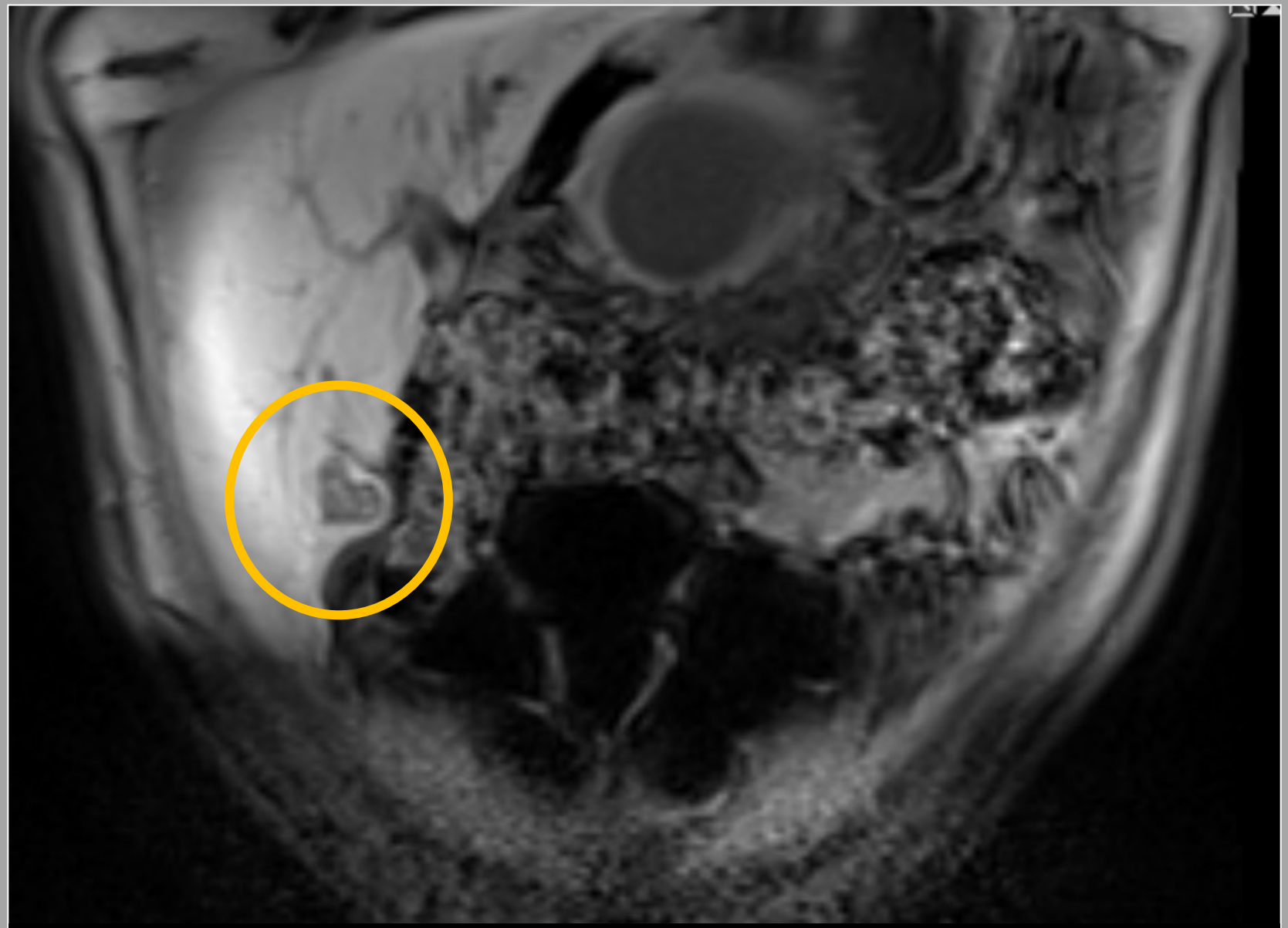

Coronal T1-weighted MRI in hepatobiliary phase

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Outline

- Lecture
  - Mechanism of action
  - Added value in characterization
  - Pitfalls and limitations 
- Case-based interactive discussion
  - Take-home

Outline

- Lecture
  - ***Mechanism of action***
  - Added value in characterization
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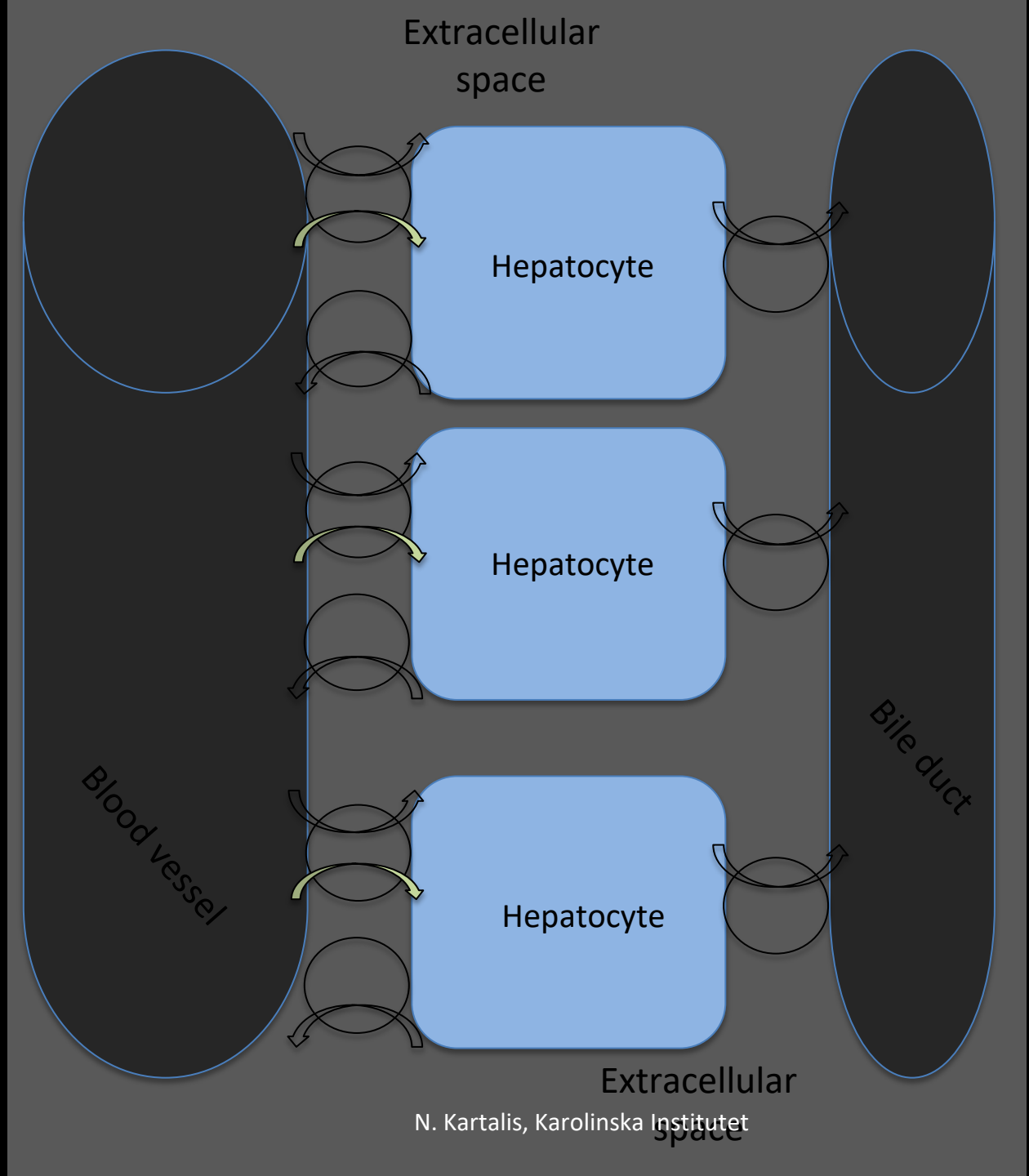
Extracellular CA (CT + MRI)


Extracellular space
Hepatocyte
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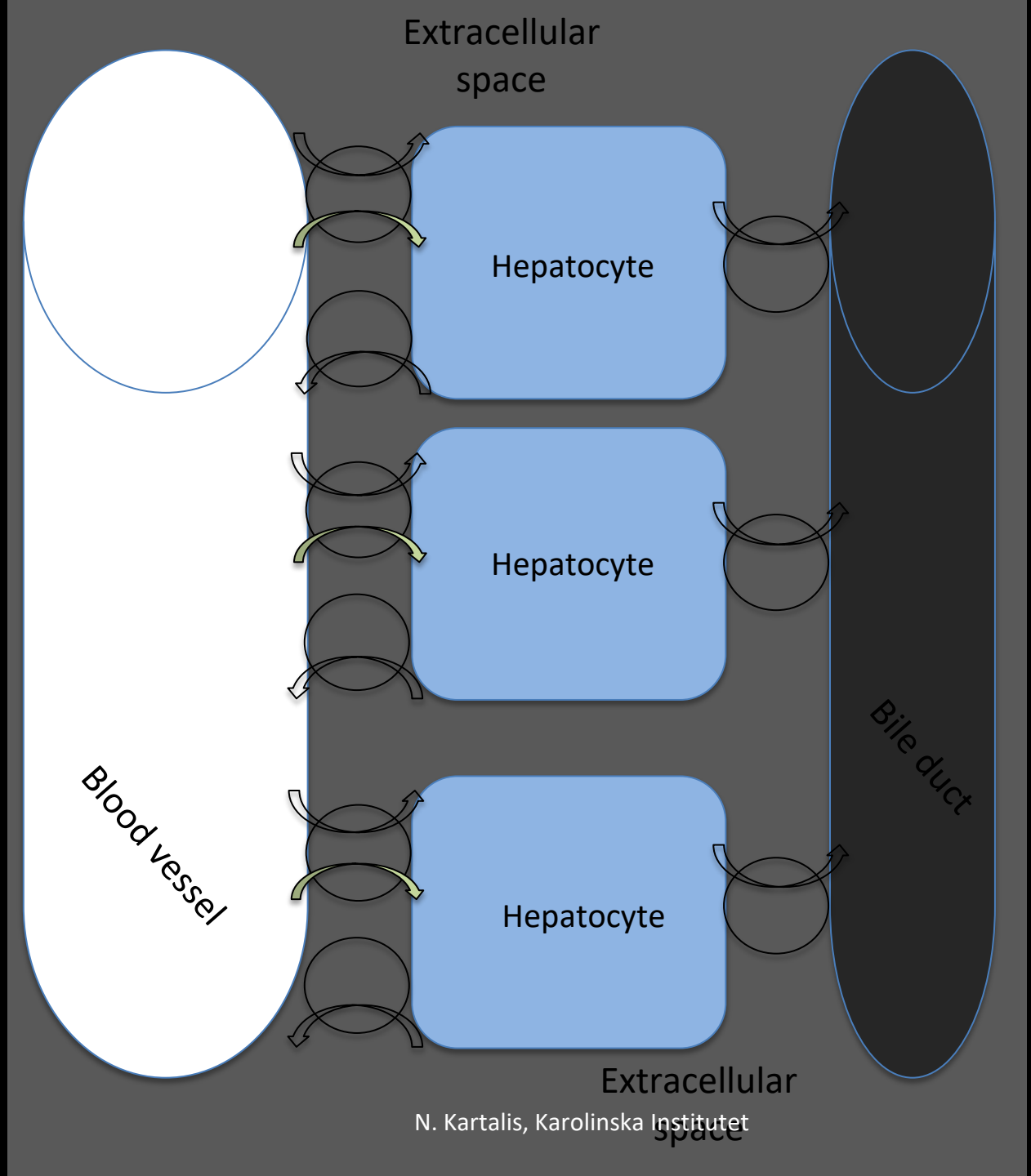
Blood vessel
Bile duct
Extracellular space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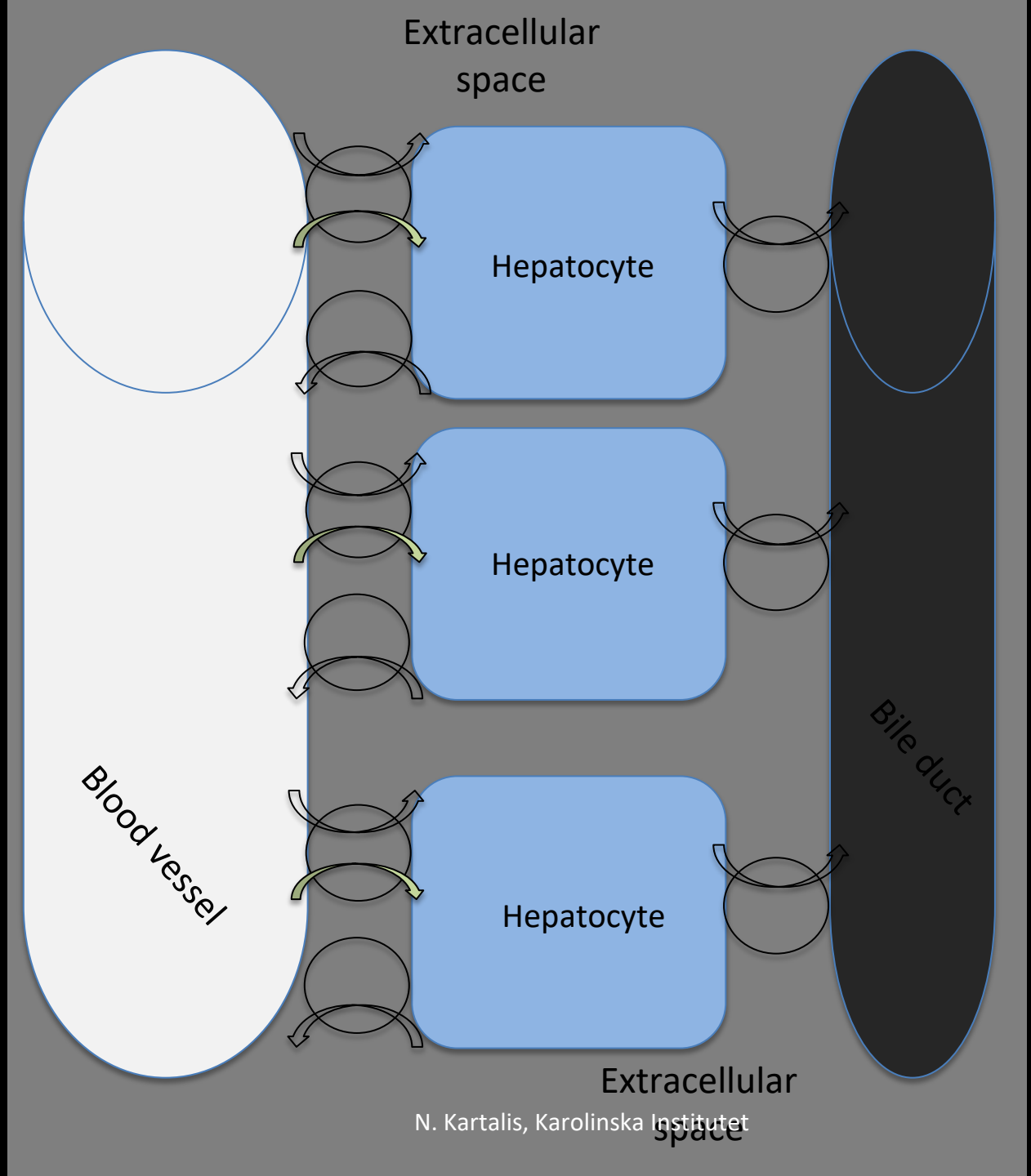
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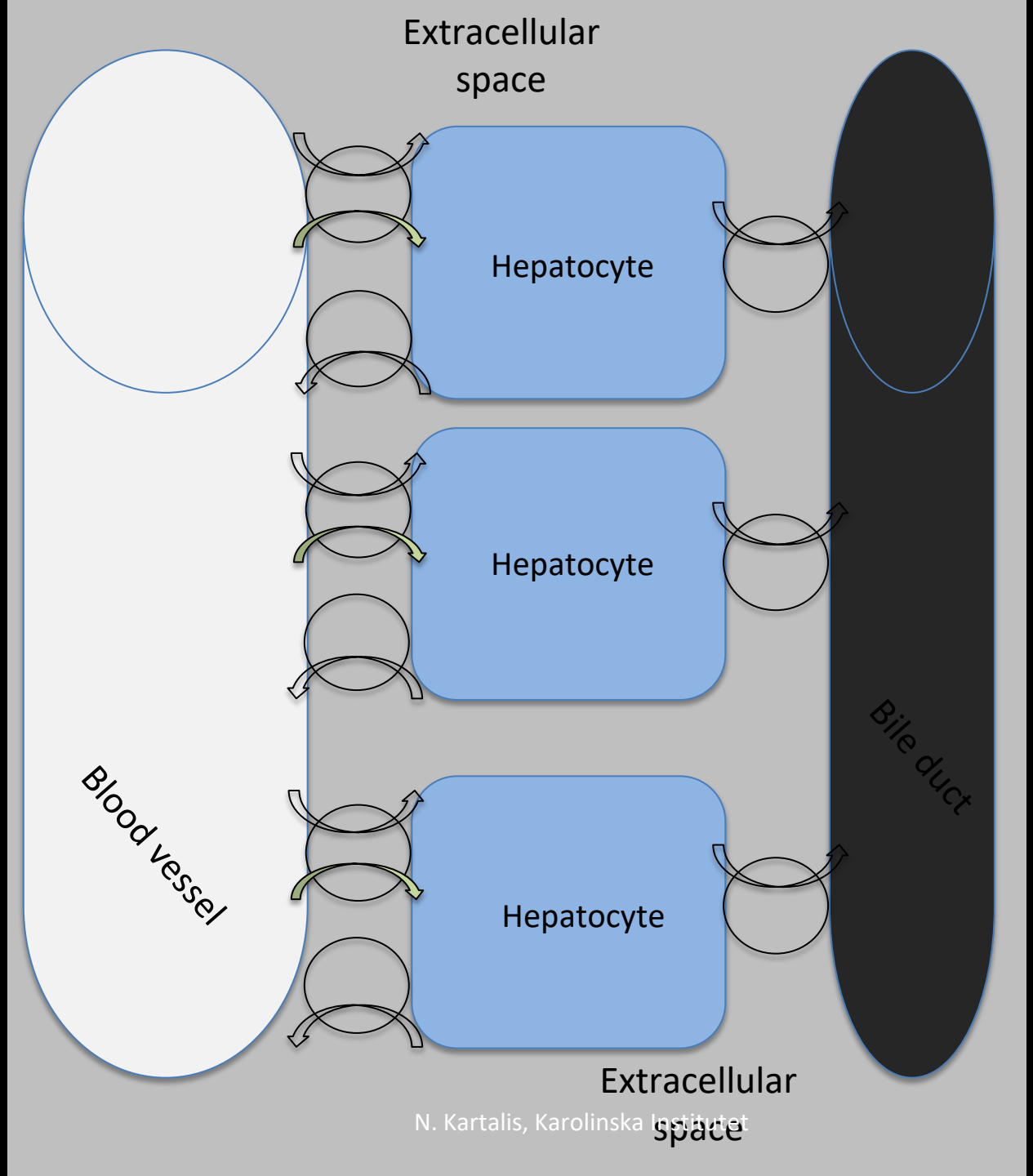
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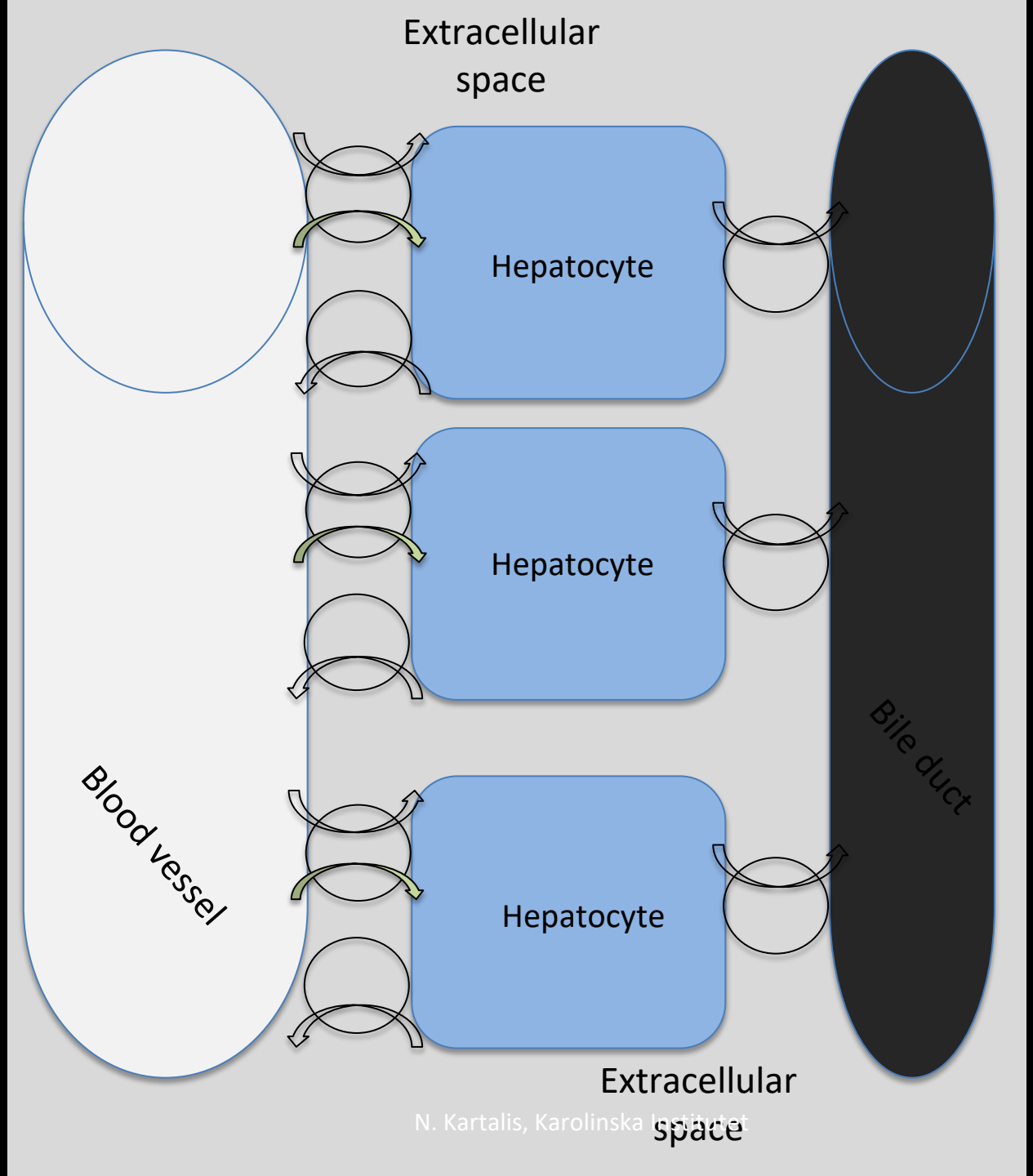
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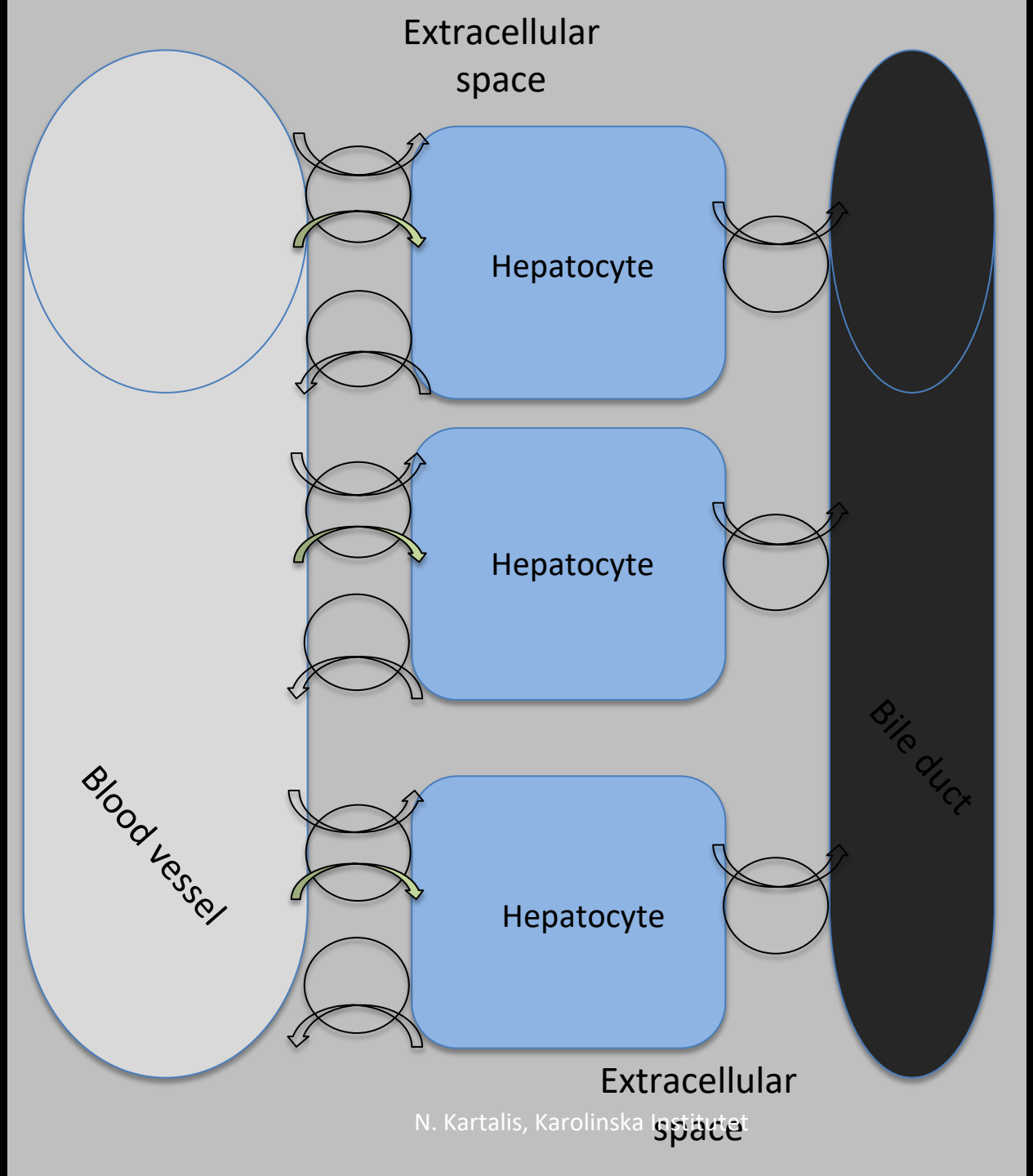
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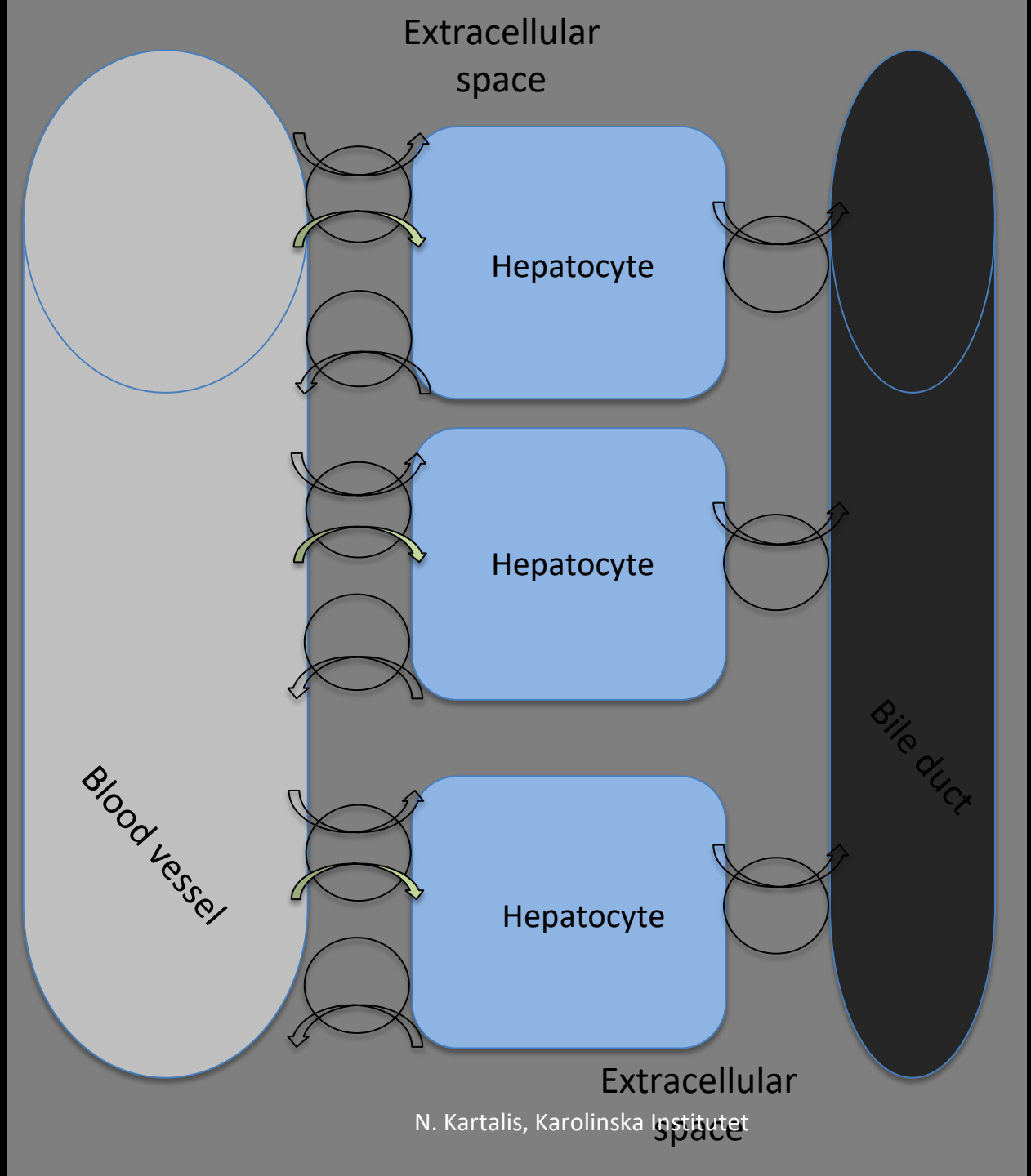
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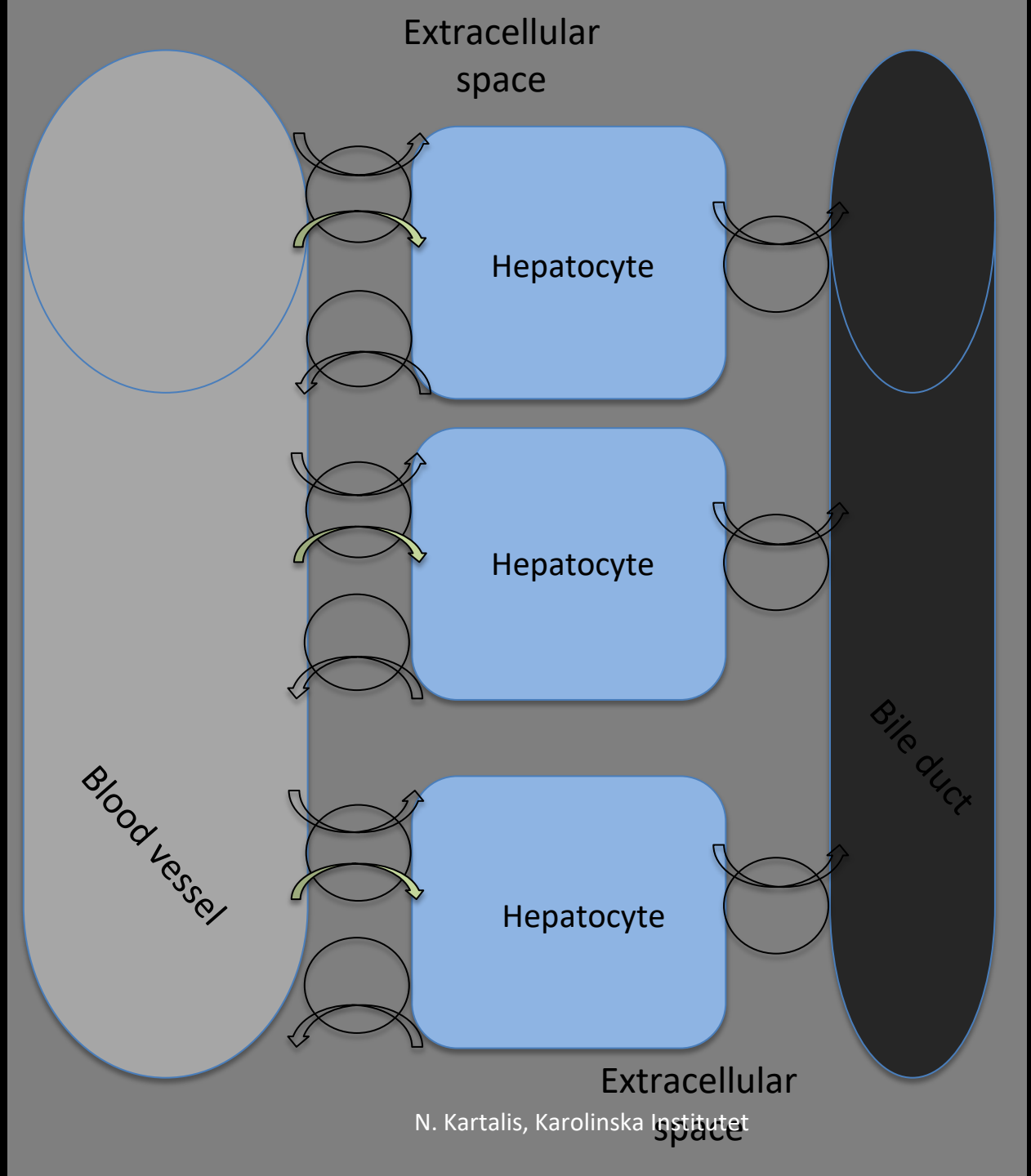
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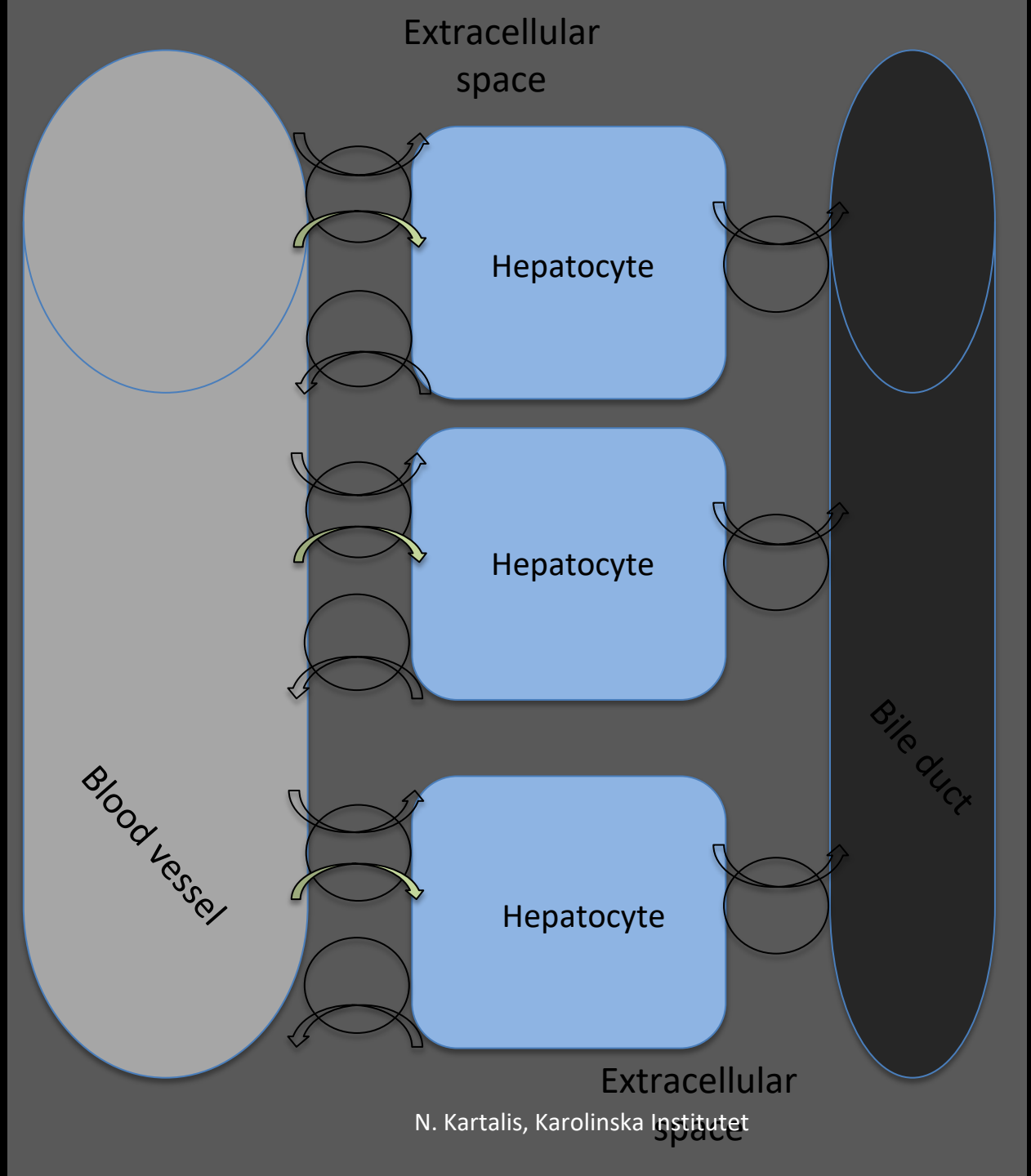
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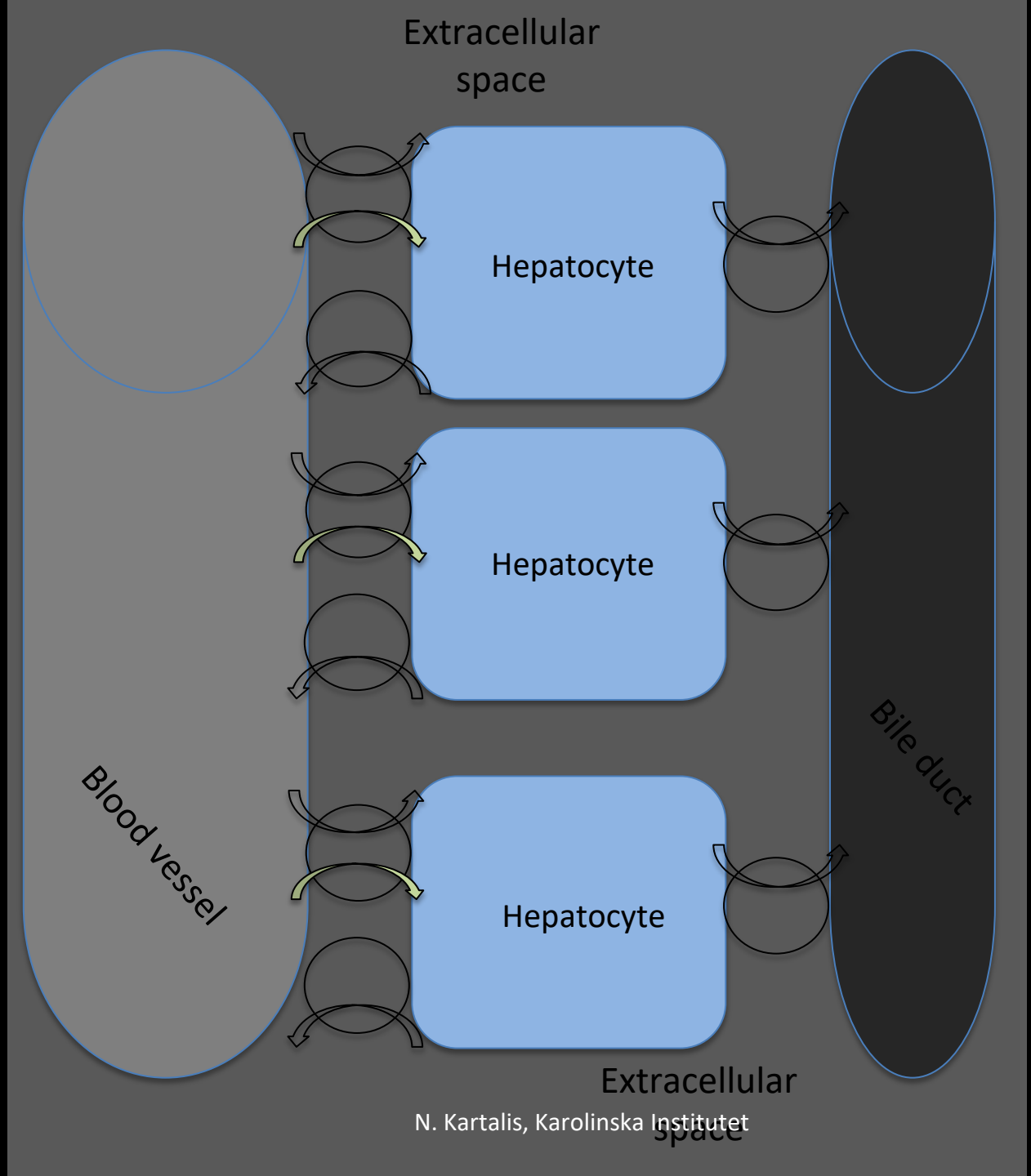
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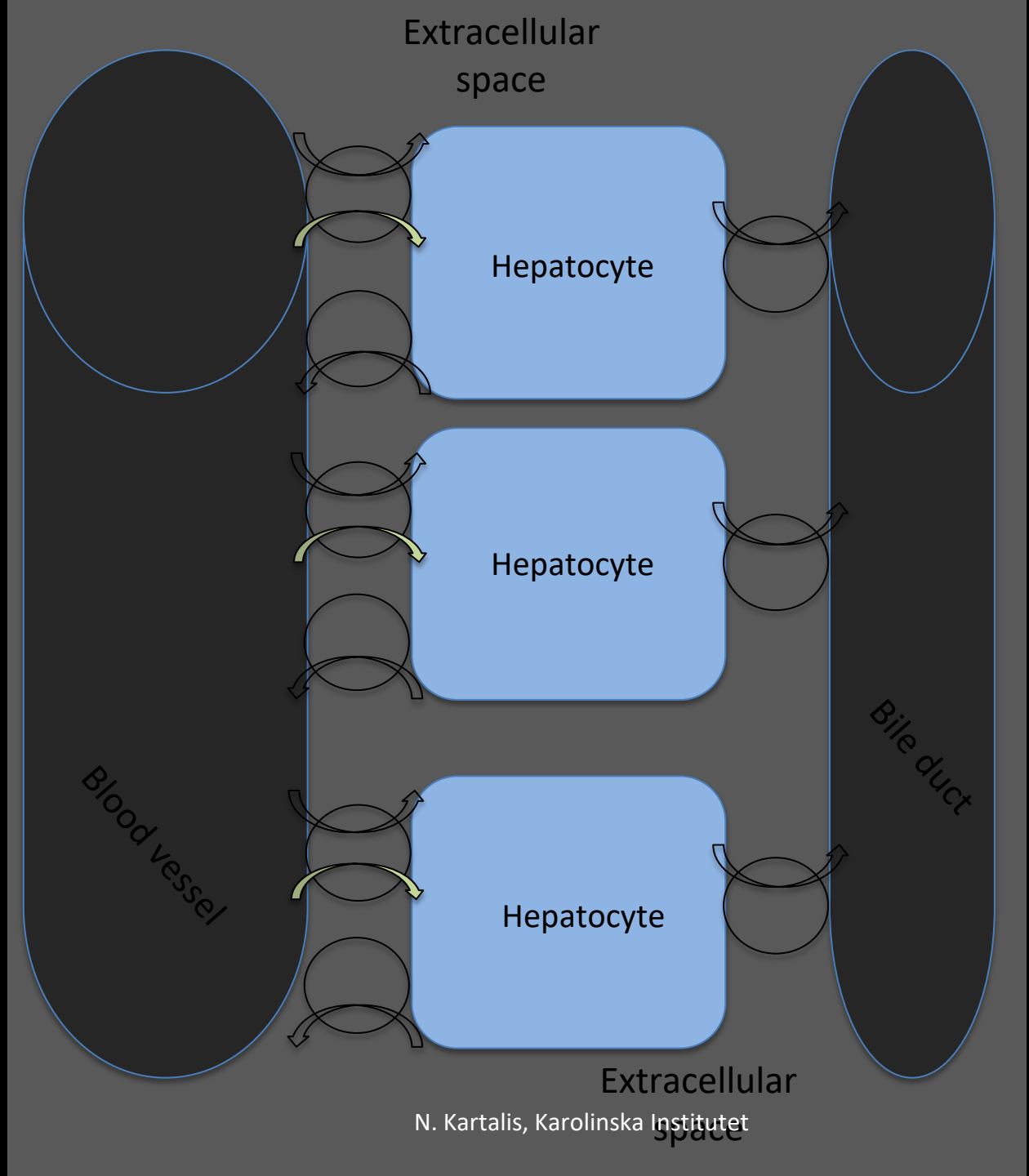
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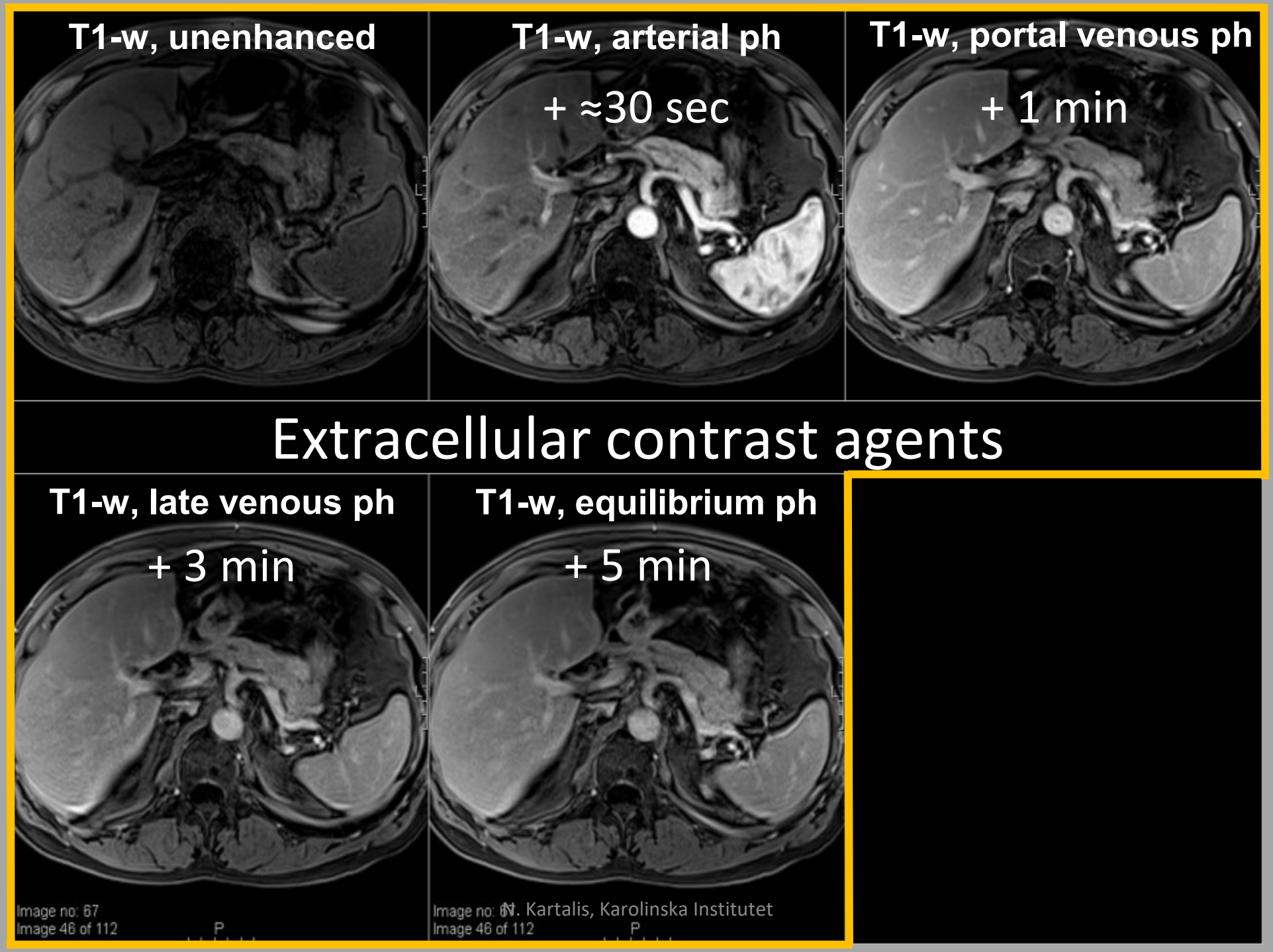
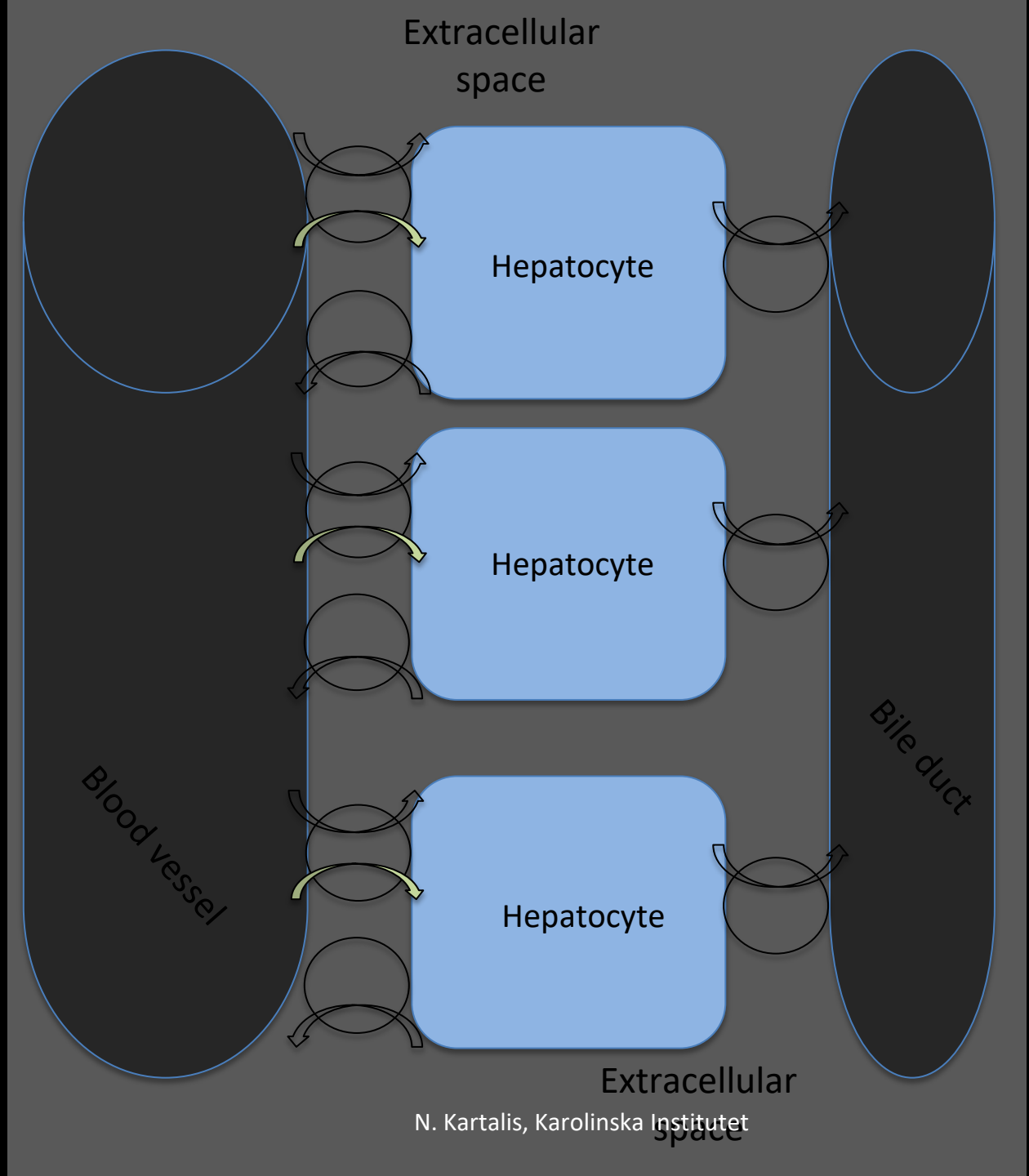


Liver-specific contrast agents (MRI)

- Gadobenate dimeglumine
  Gd-BOPTA
  MultiHance

- Gadoxetic acid
  Gd-EOB-DTPA
  Primovist/Eovist

www.medicines.org.uk/emc/medicine/6132. Accessed on June 18, 2024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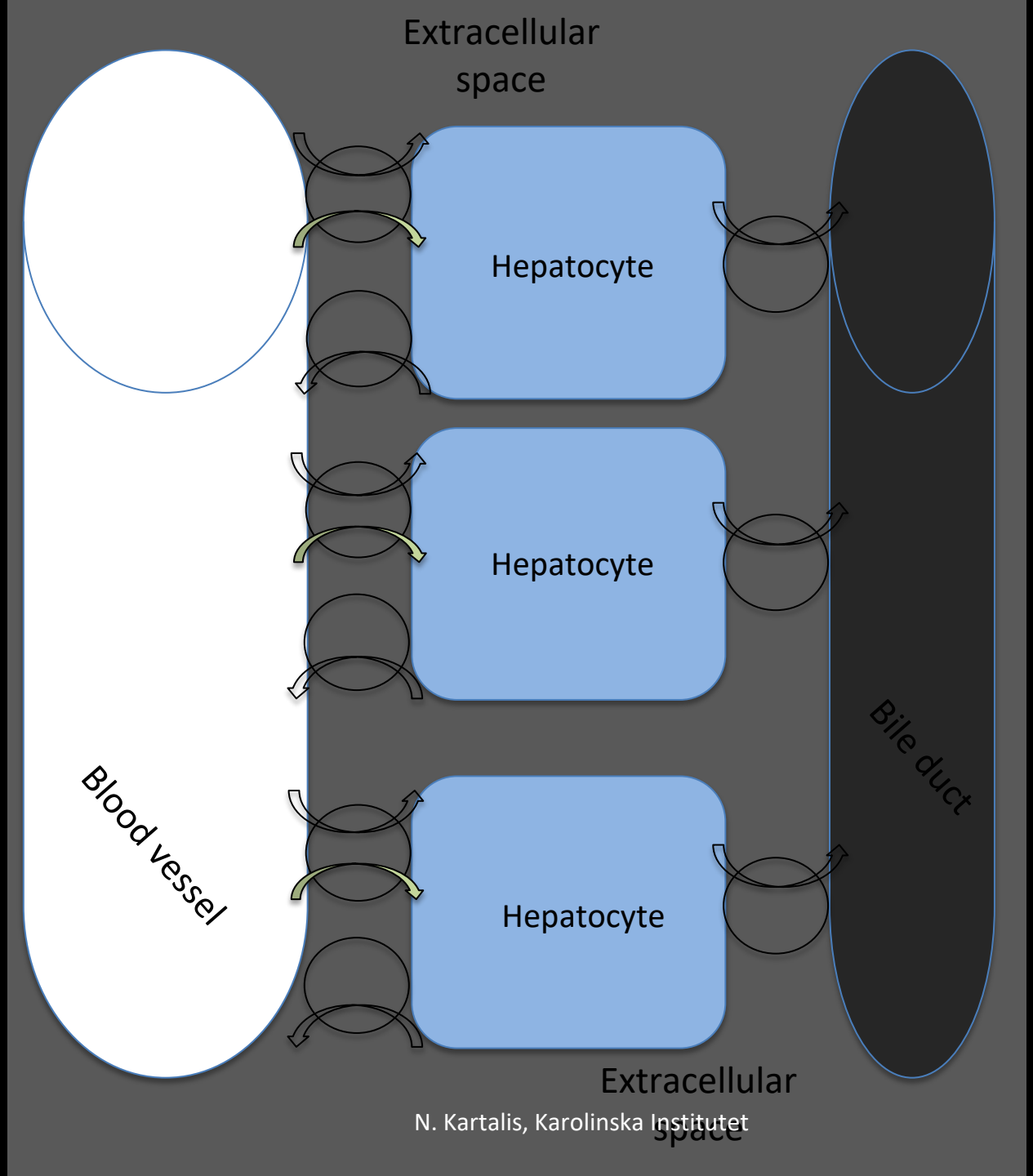
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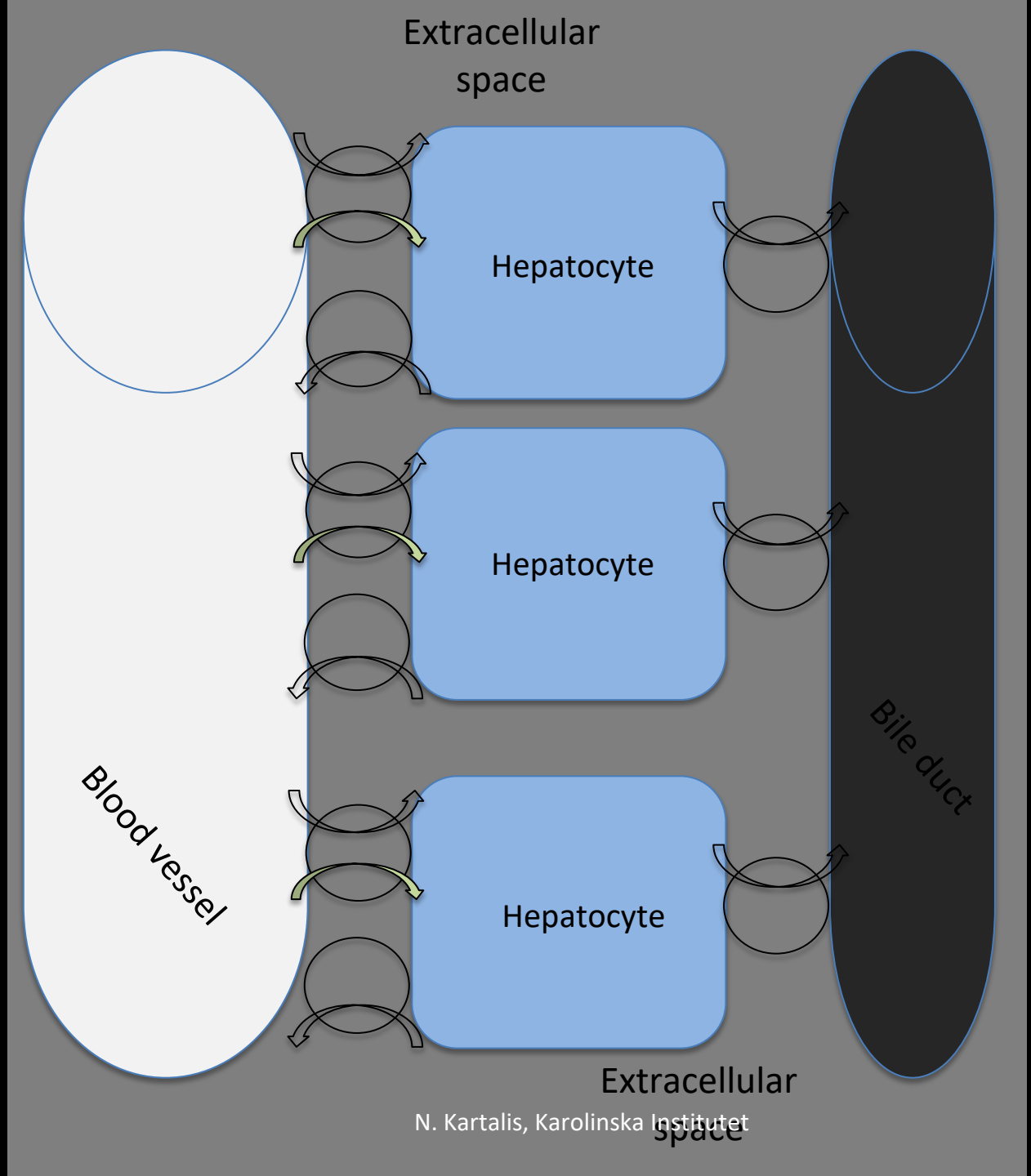
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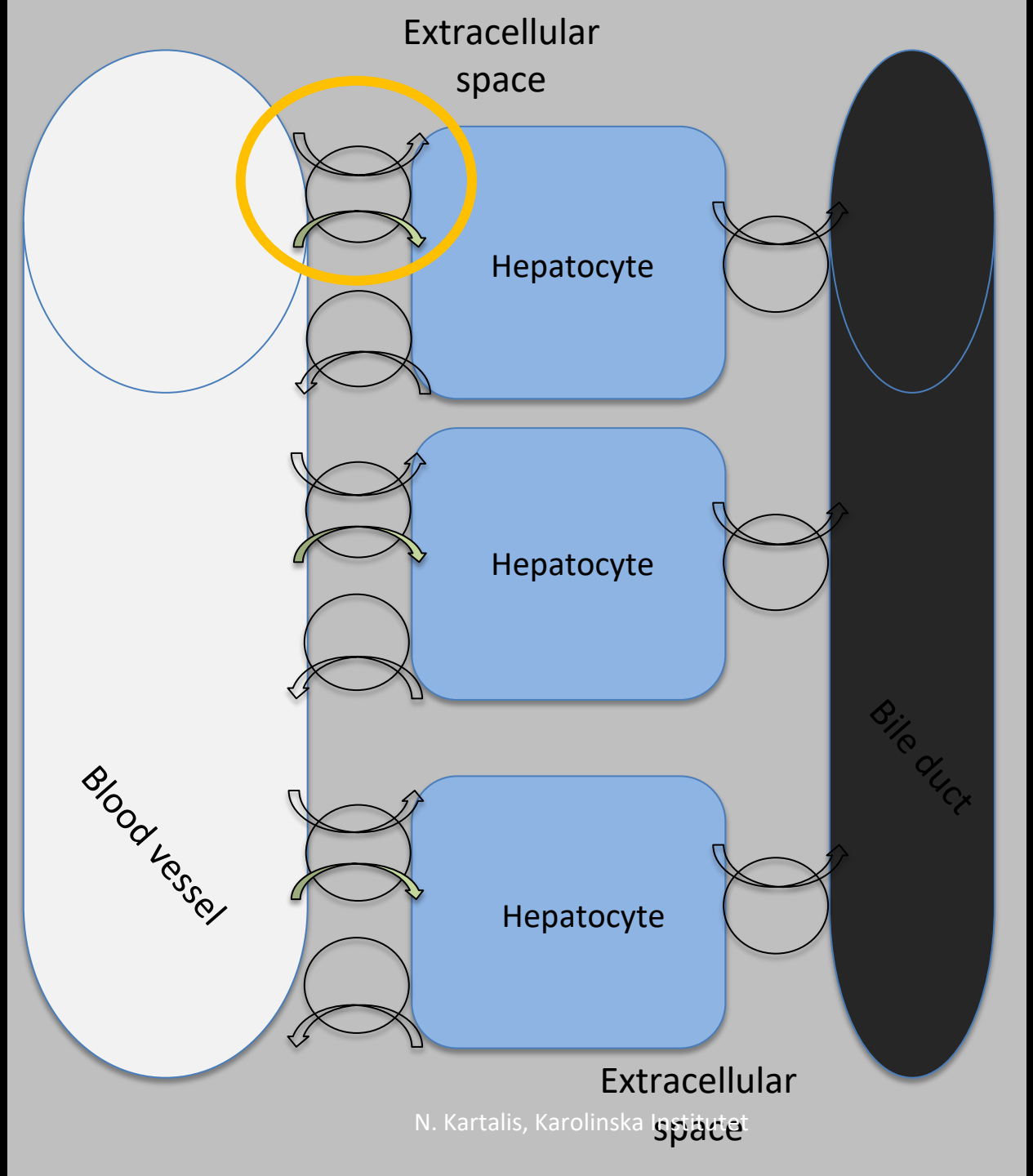
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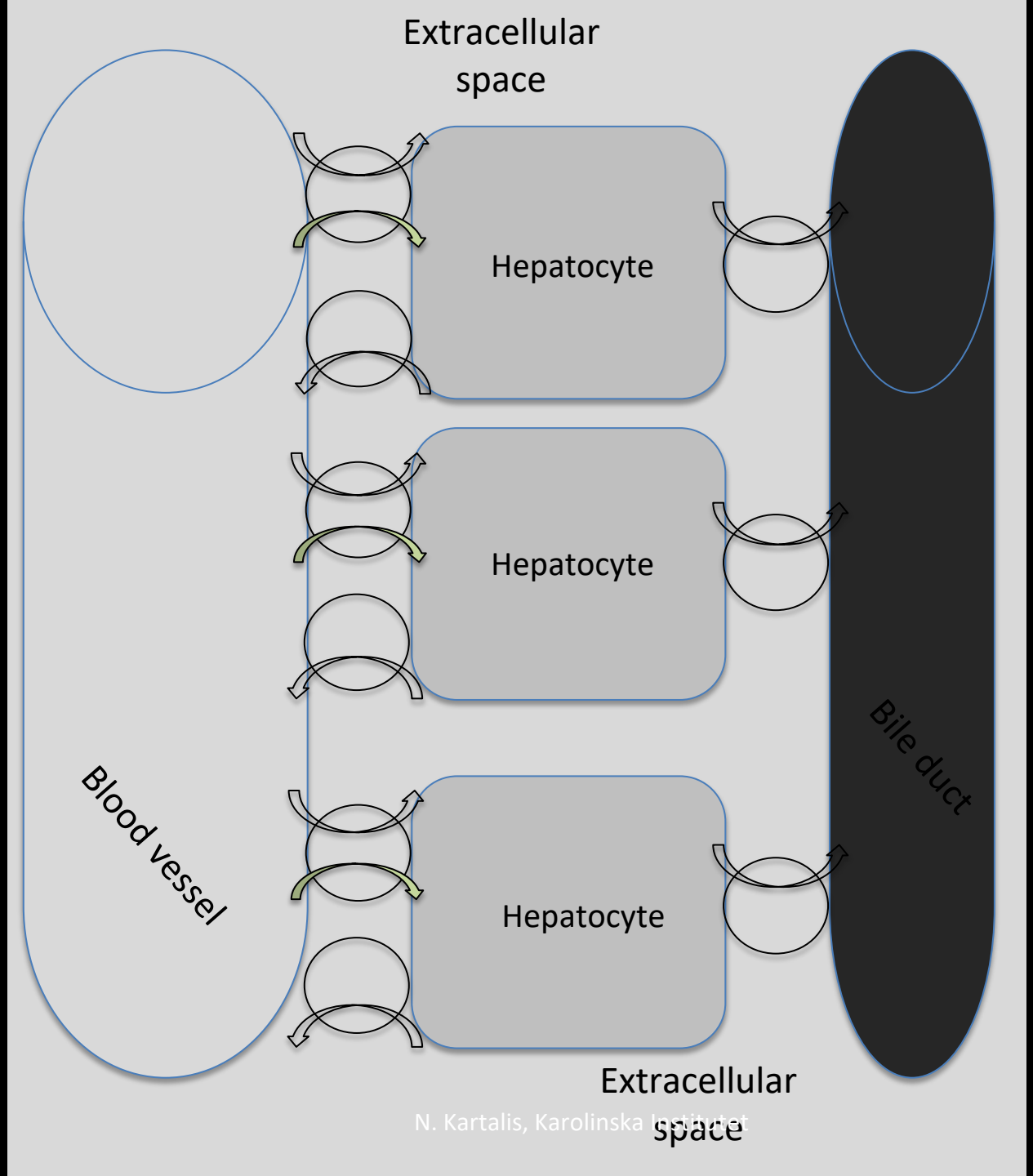
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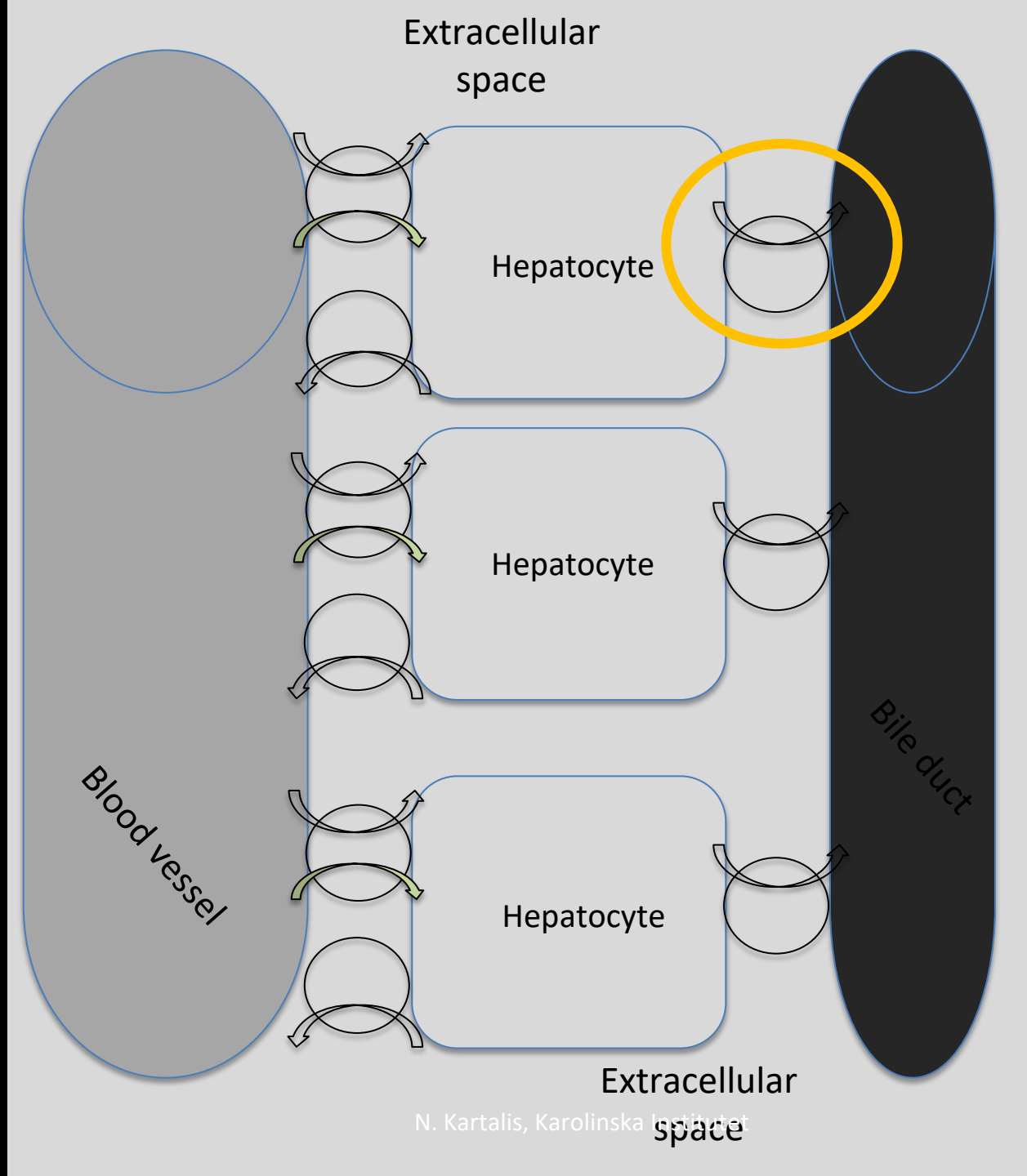
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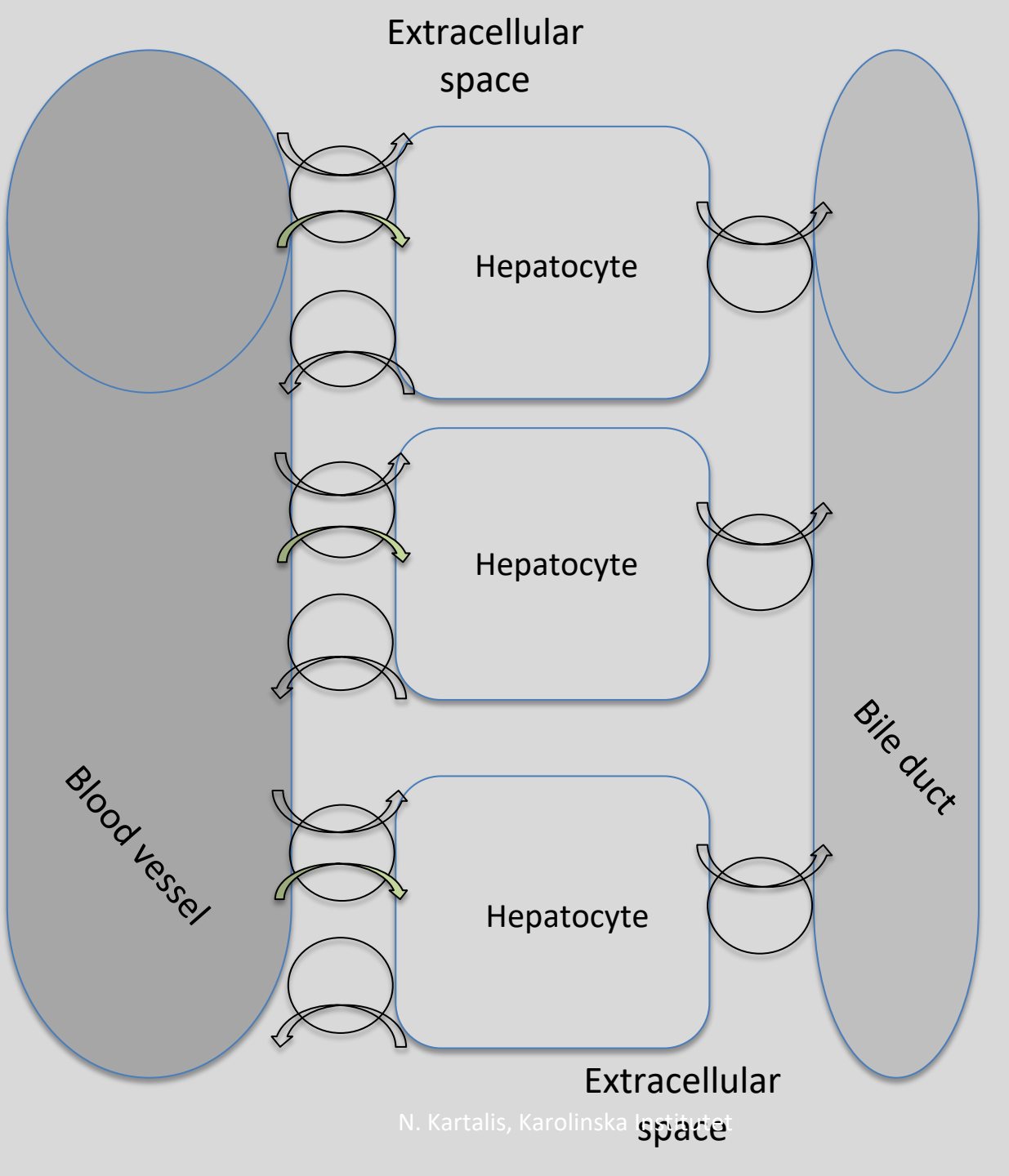
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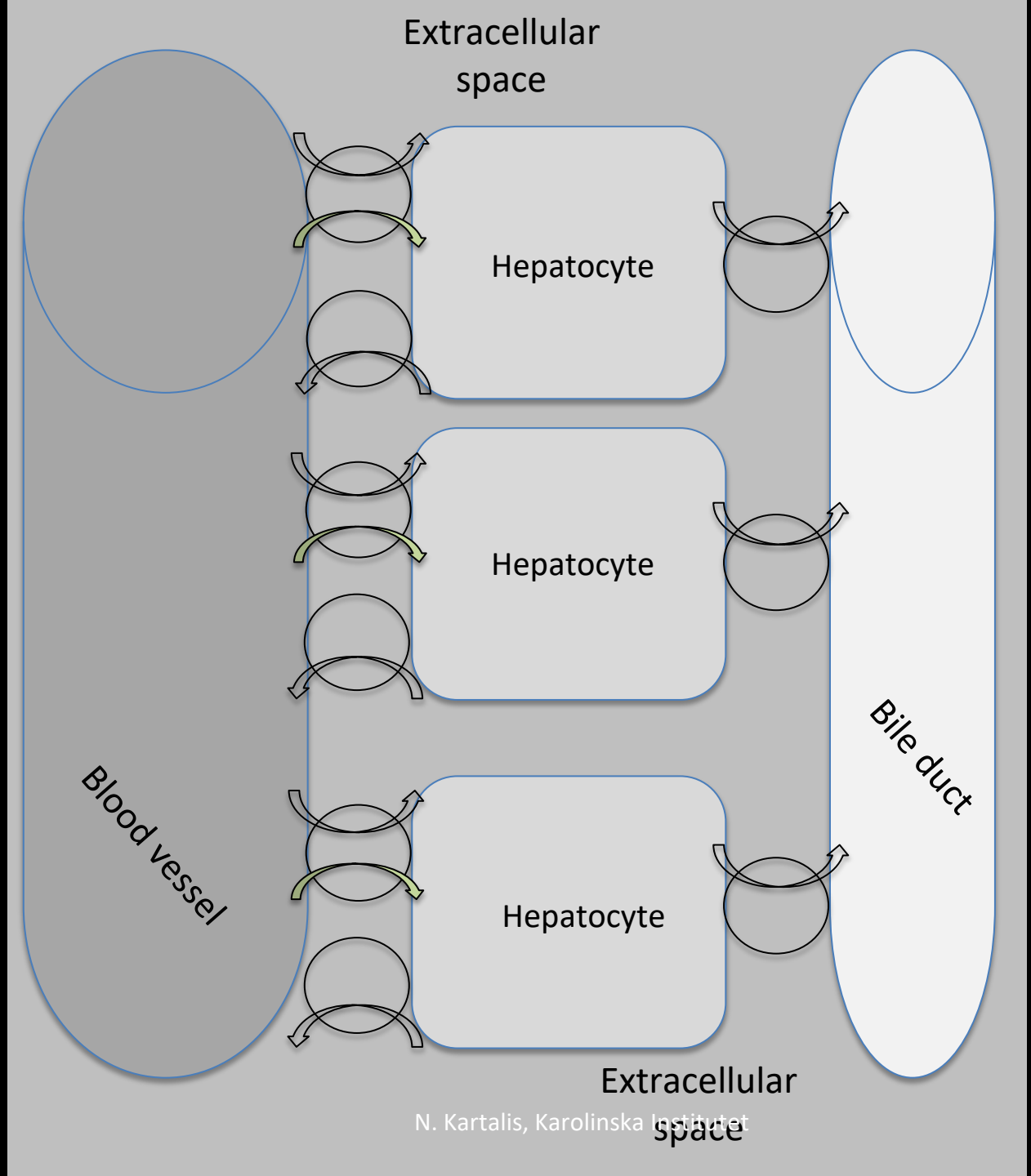
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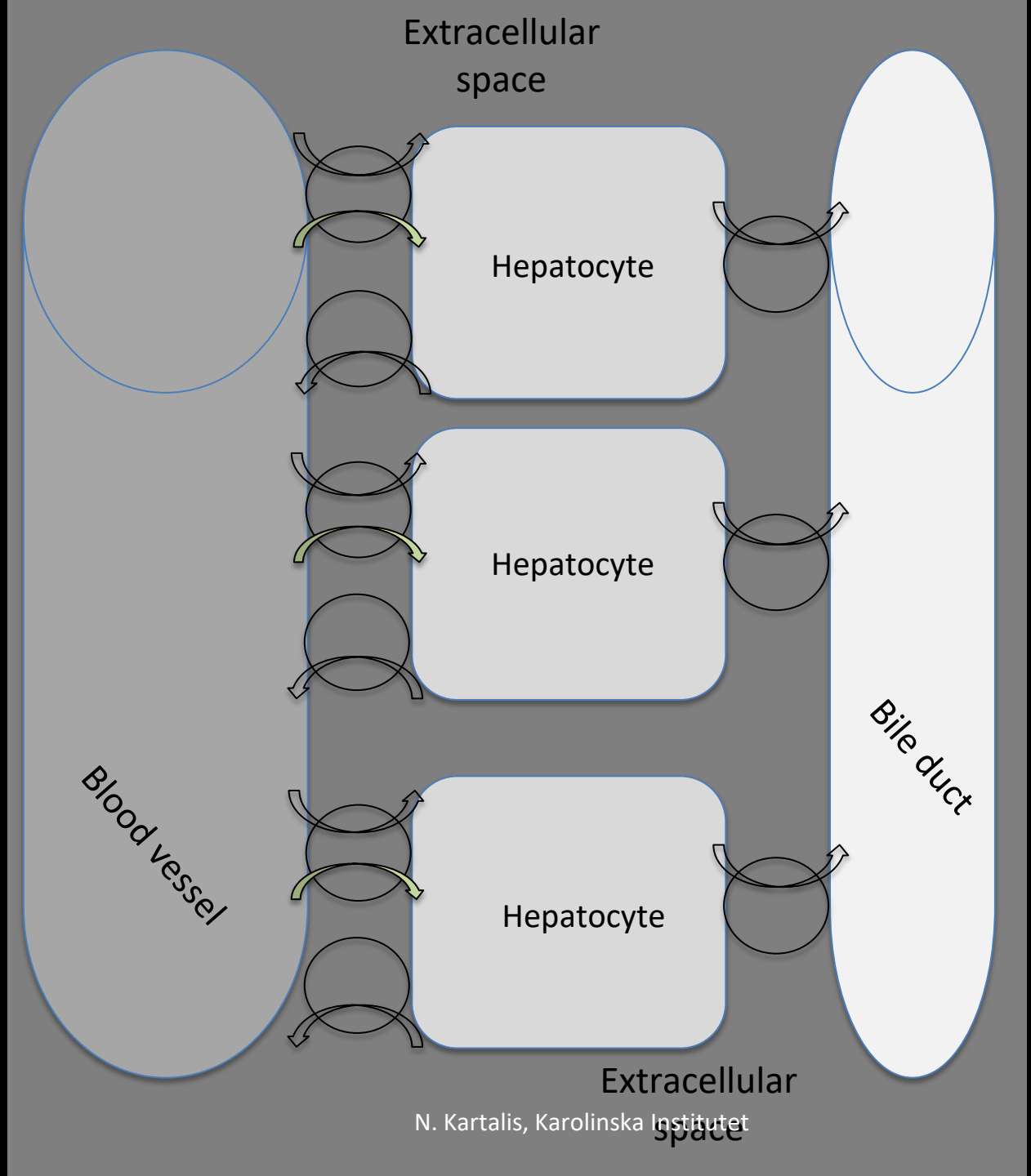
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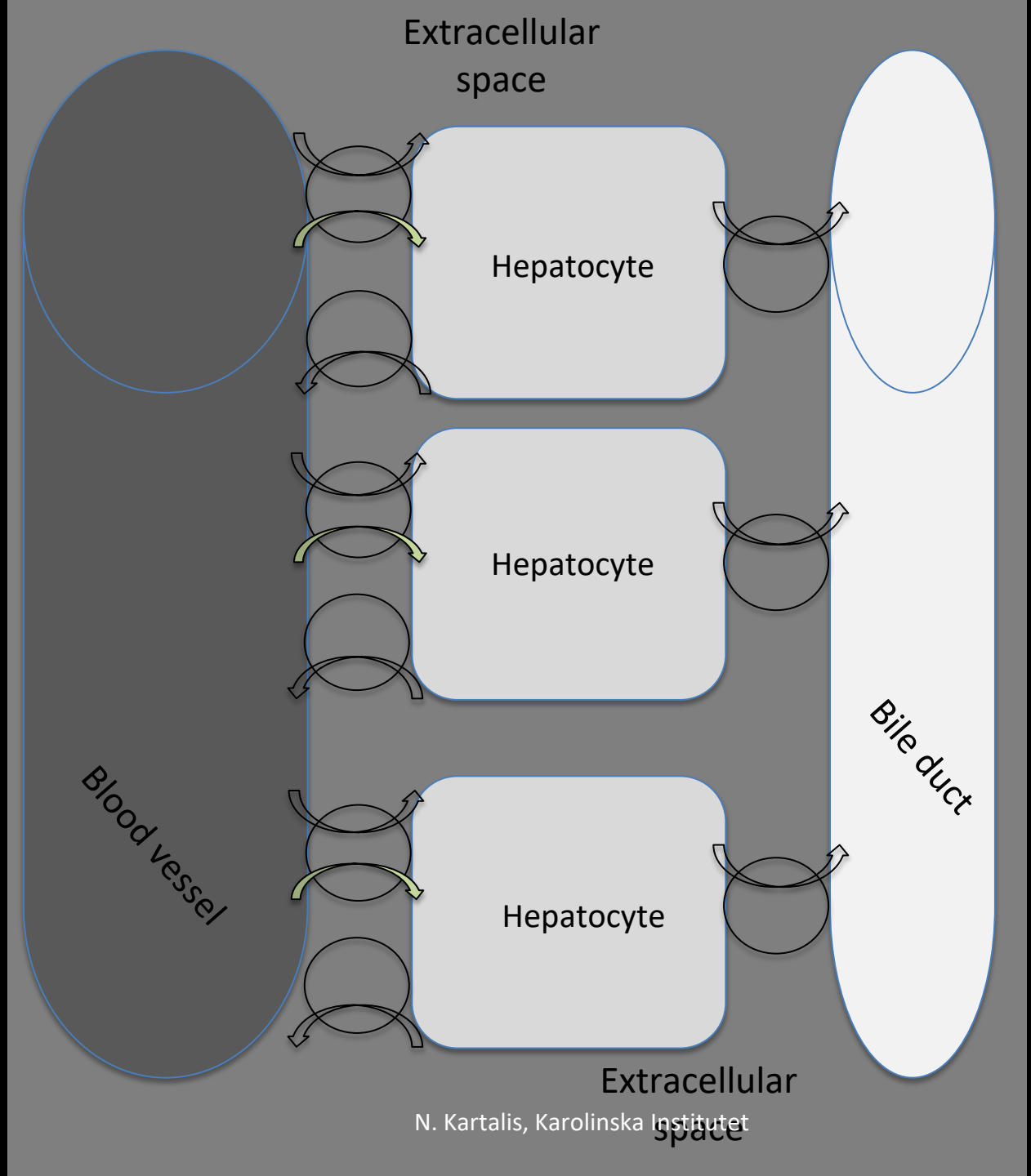
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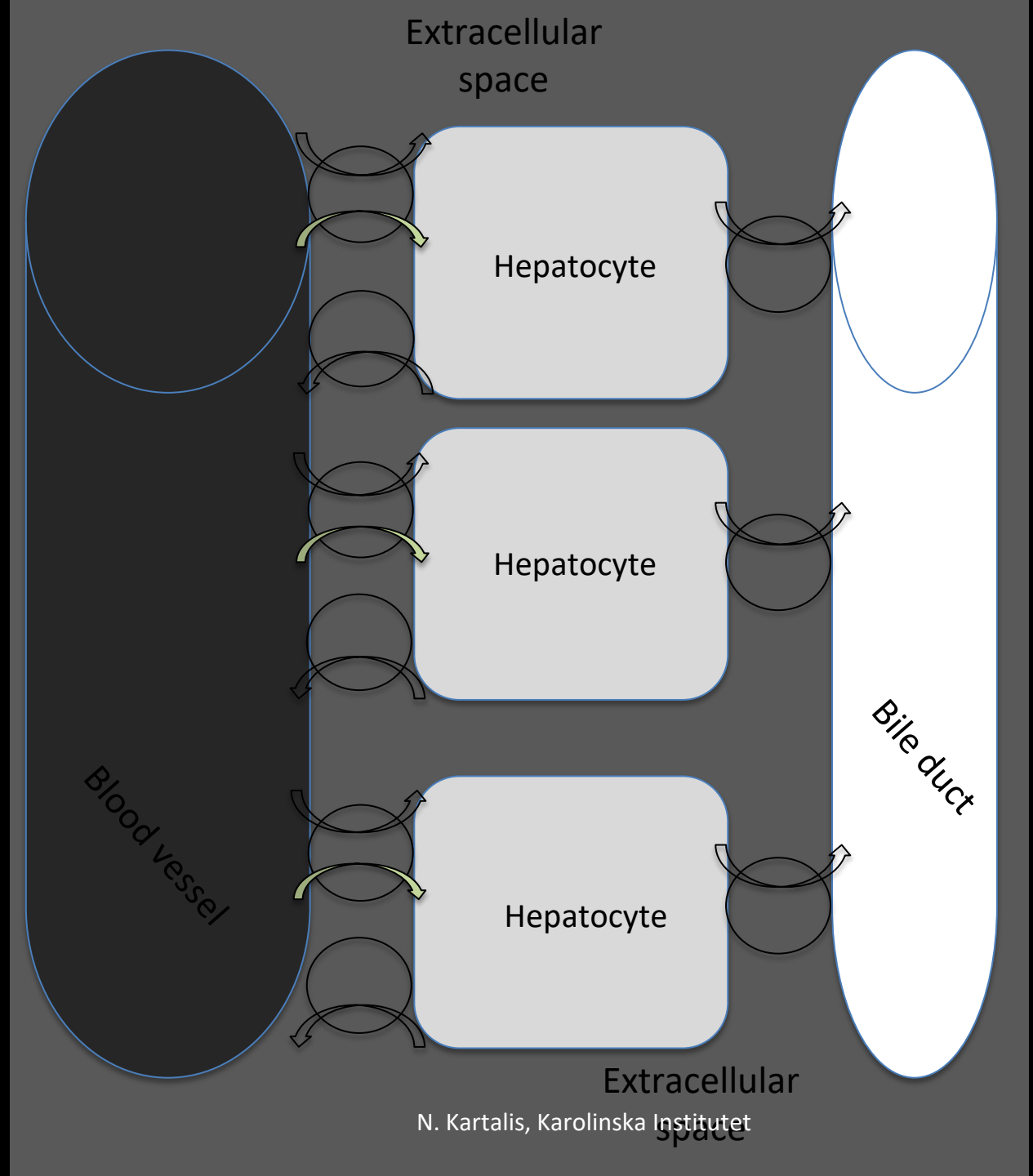
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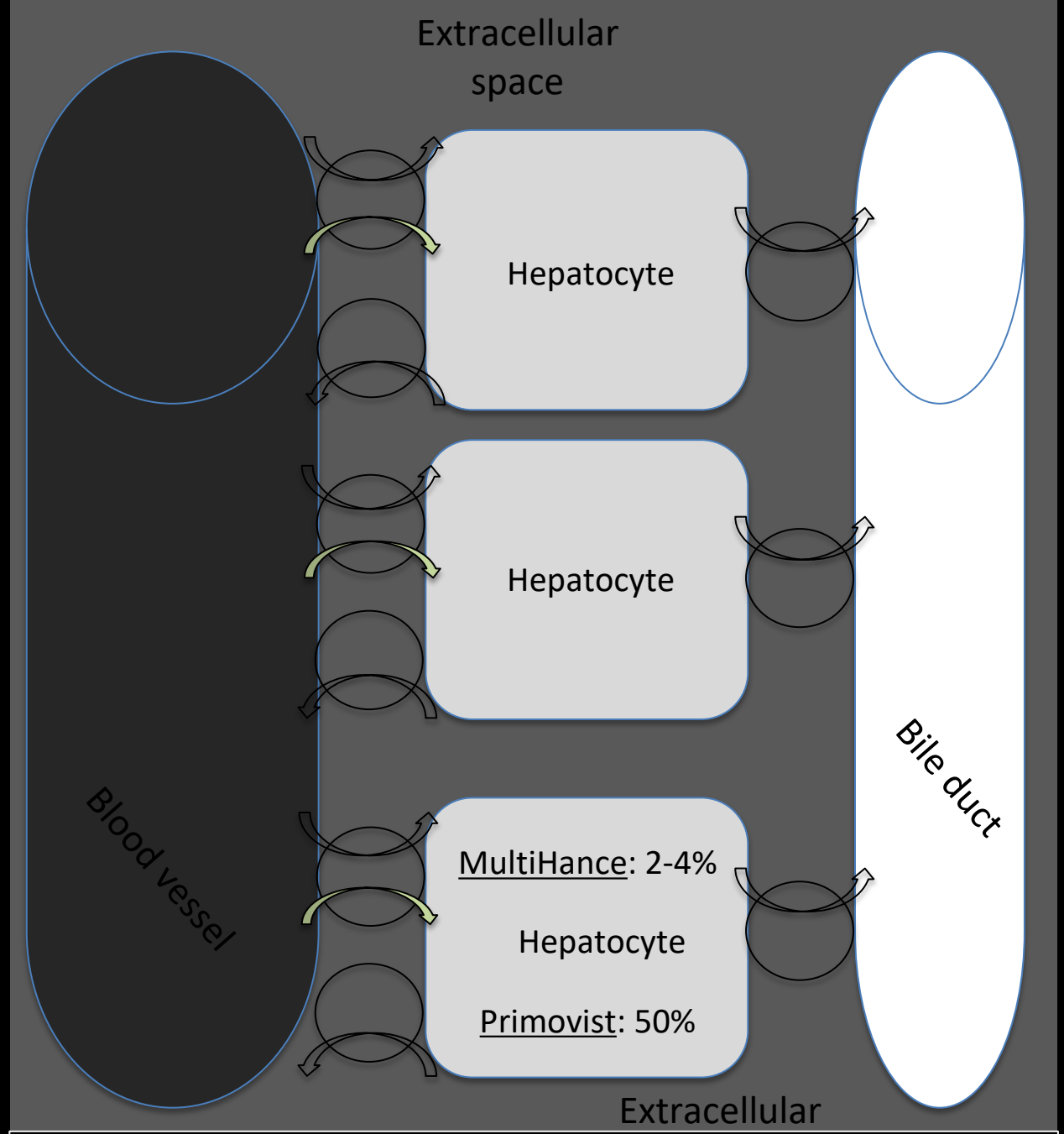

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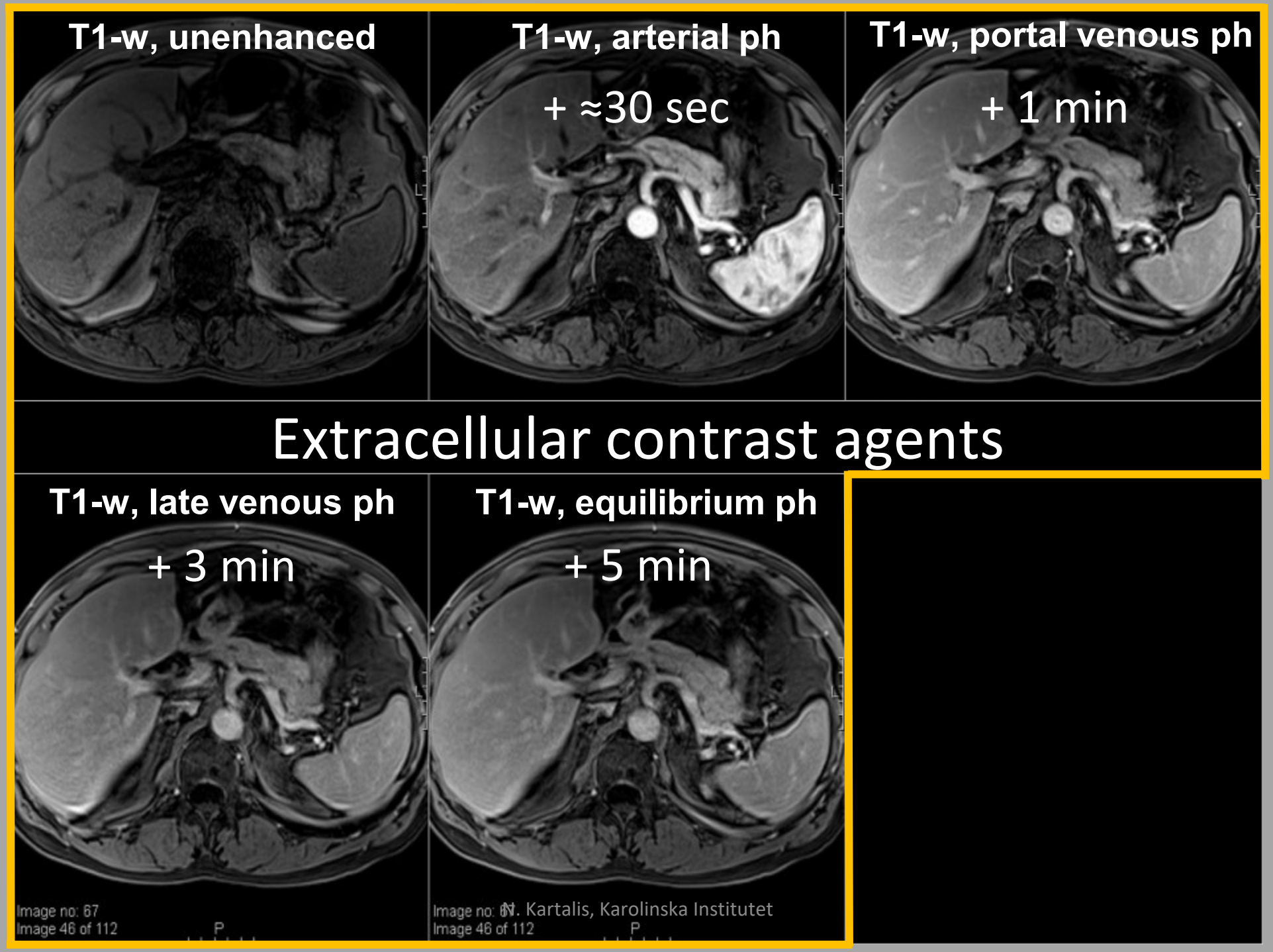
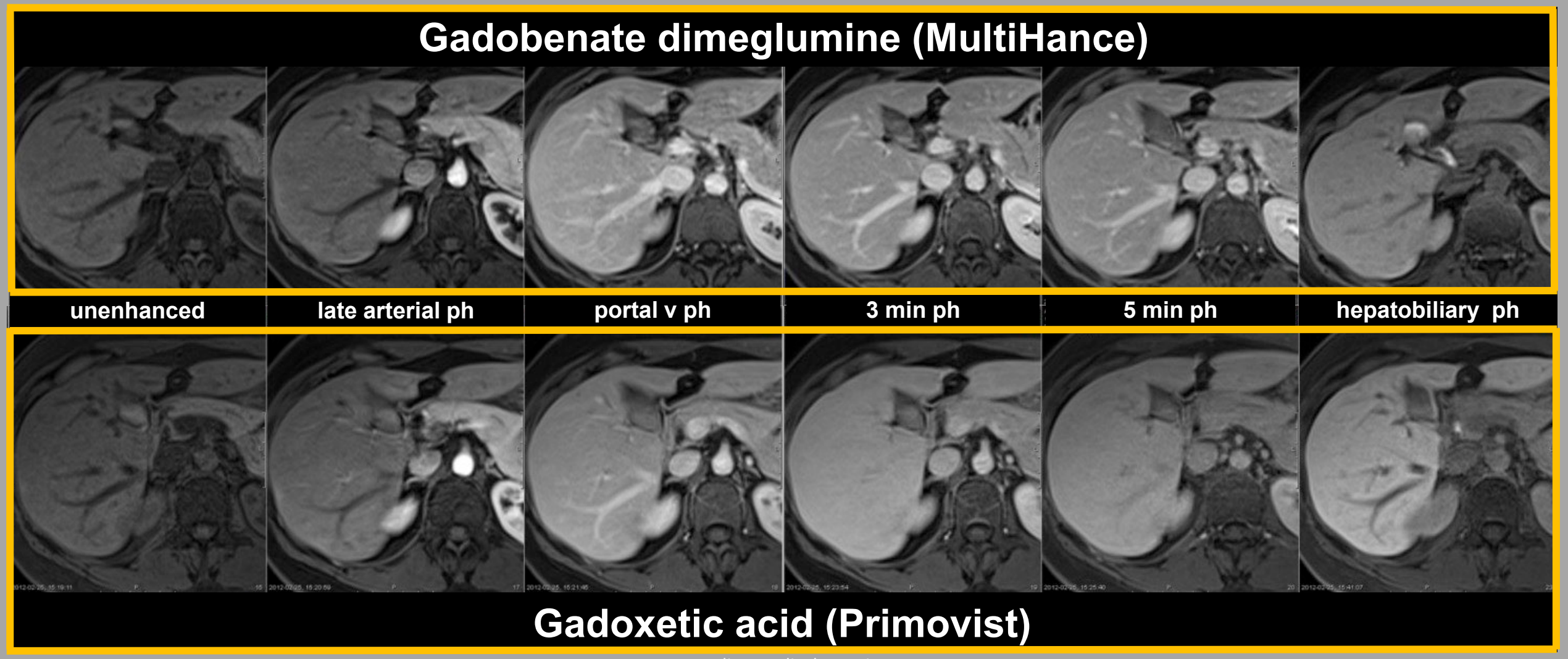
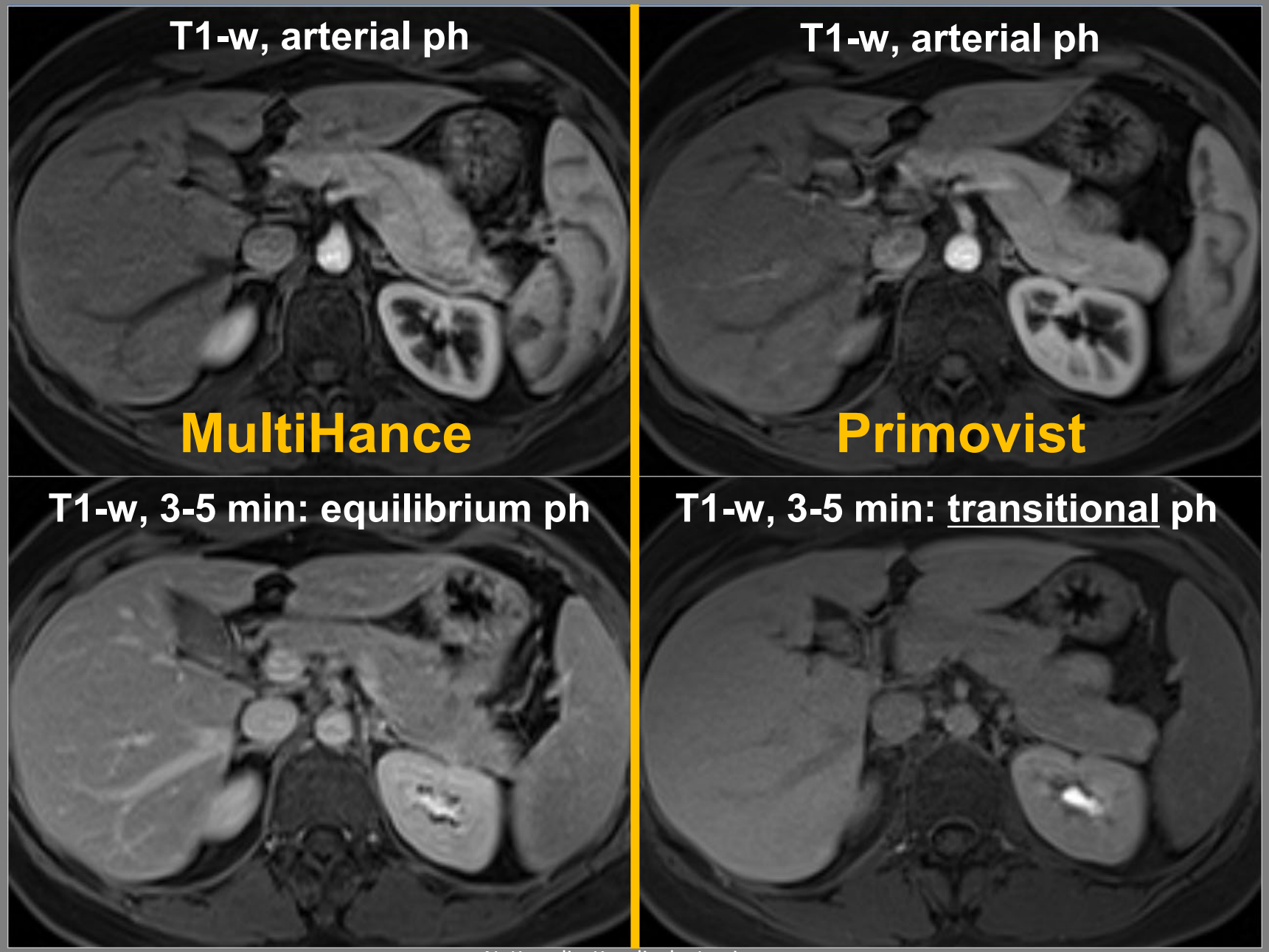


Liver-specific contrast agents (MRI)





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Technique LS-CA

	• Gadobenate dimeglumine Gd-BOPTA **MultiHance**	• Gadoxetic acid Gd-EOB-DTPA **Primovist**
Excretion:	– 5% hepatobiliary & 95% renal	– 50% hepatobiliary & 50% renal
½ life:	– 1-2 h	– 1 h
Recom. dose @ inj. rate:	– 0.05 mmol Gd/kg (=0.1 ml/kg) @ 2 ml/s	– 0.025 mmol Gd/kg (=0.1 ml/kg) @ 2 ml/s

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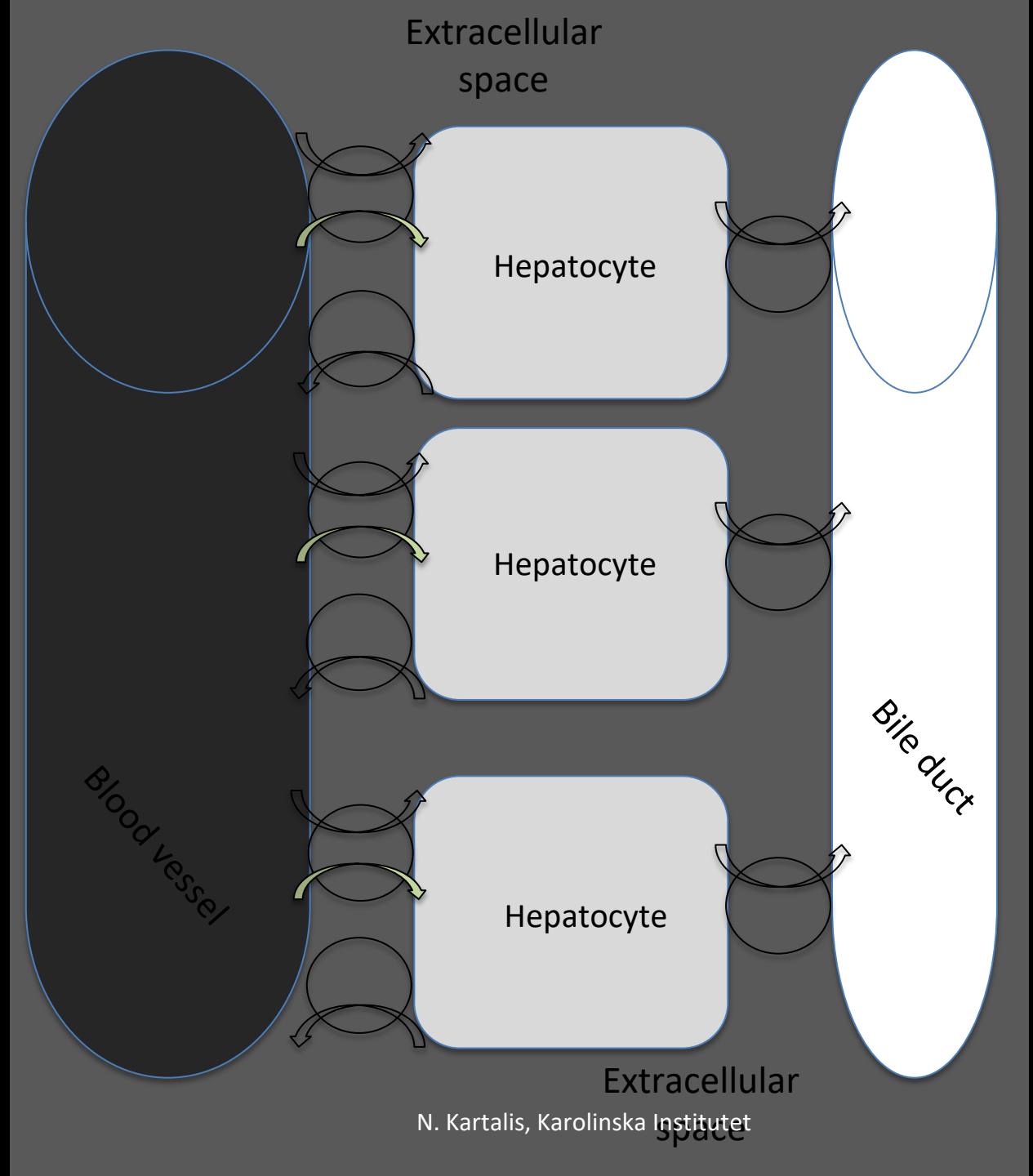
Outline

- Lecture
  - Mechanism of action
  - ***Added value in characterization***
  - Pitfalls and limitations
- Case-based interactive discussion
  - Take-home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Outline

- Lecture
  - Mechanism of action
  - ***Added value in characterization: benign***
  - Pitfalls and limitations
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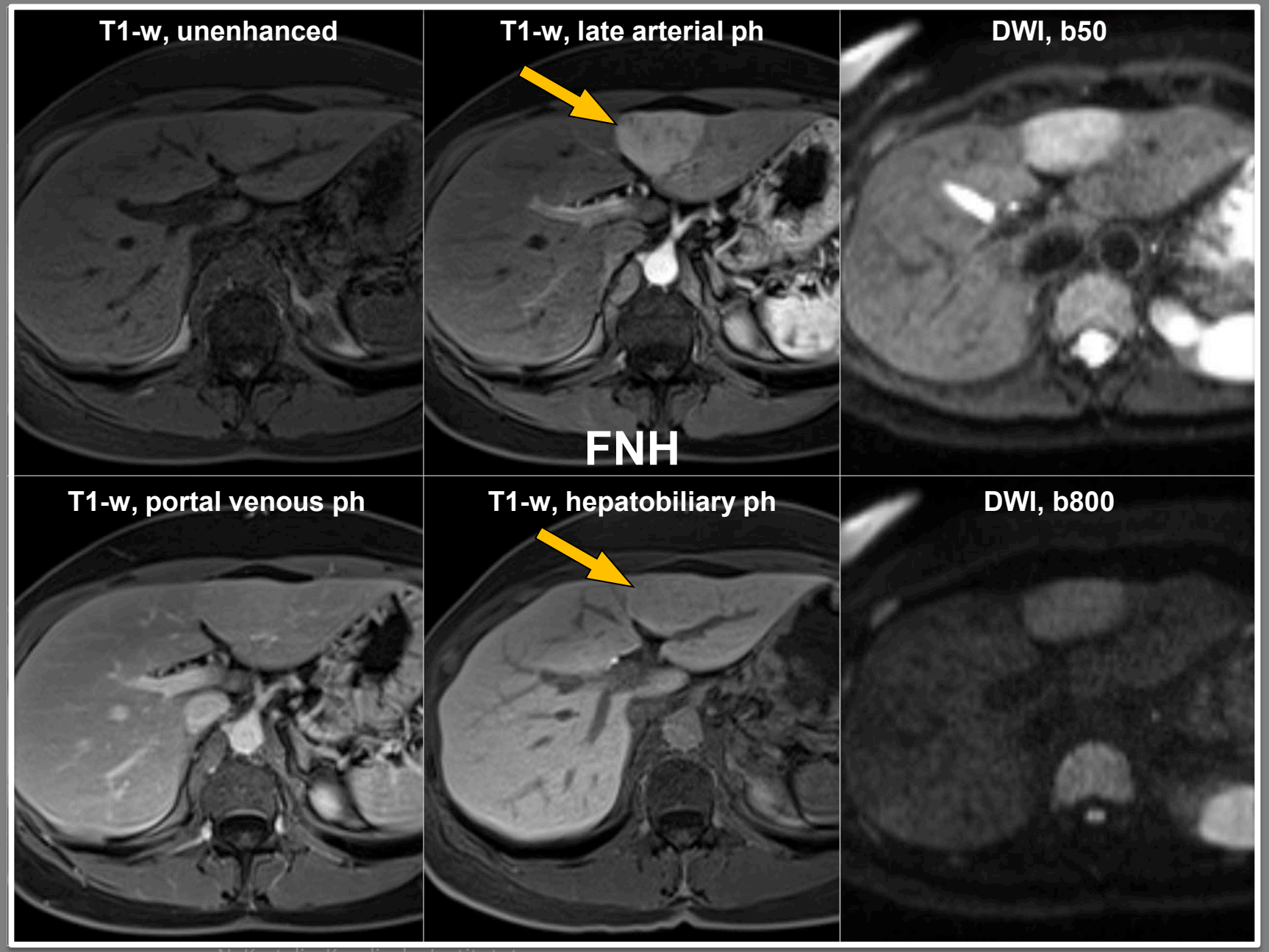
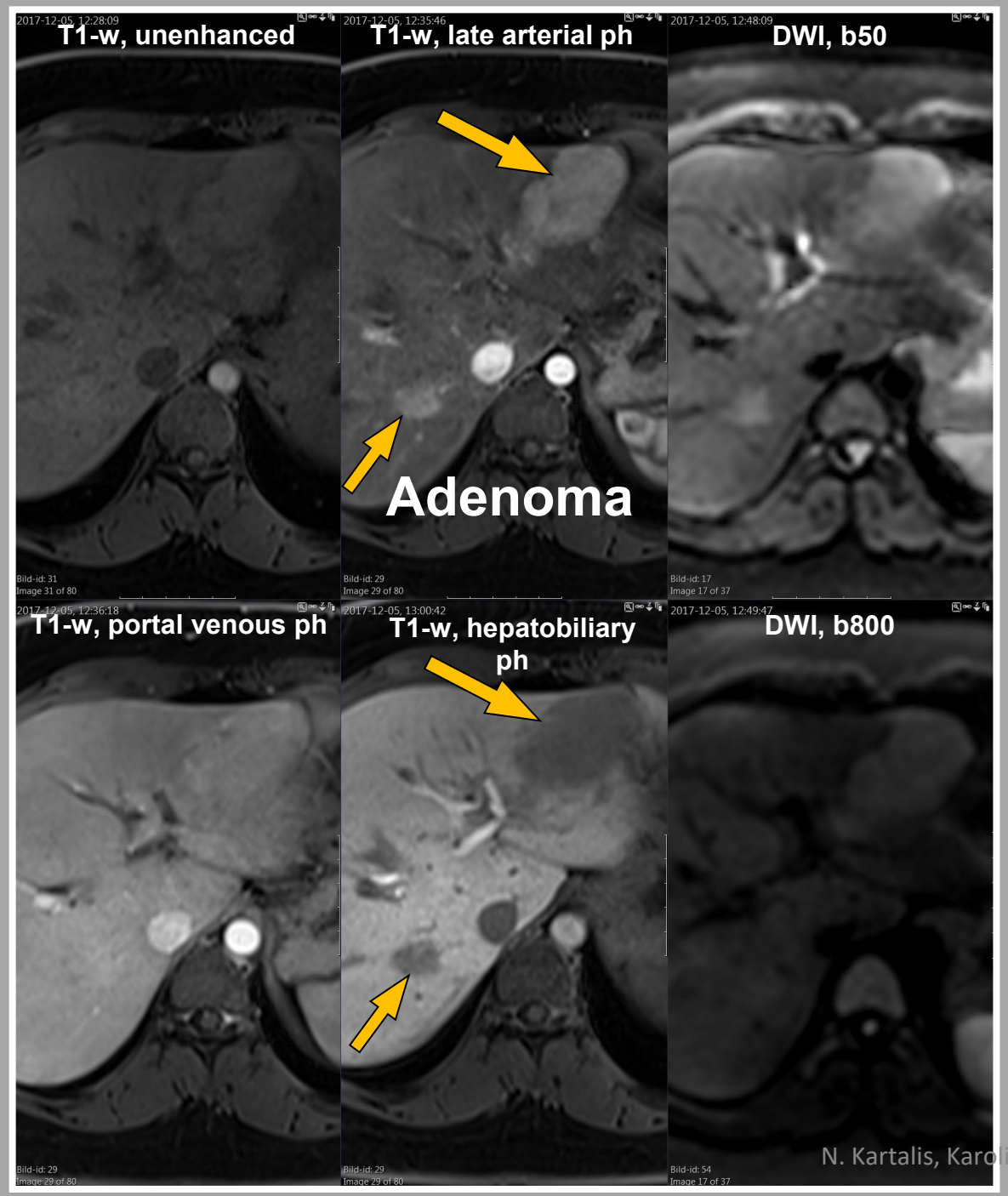
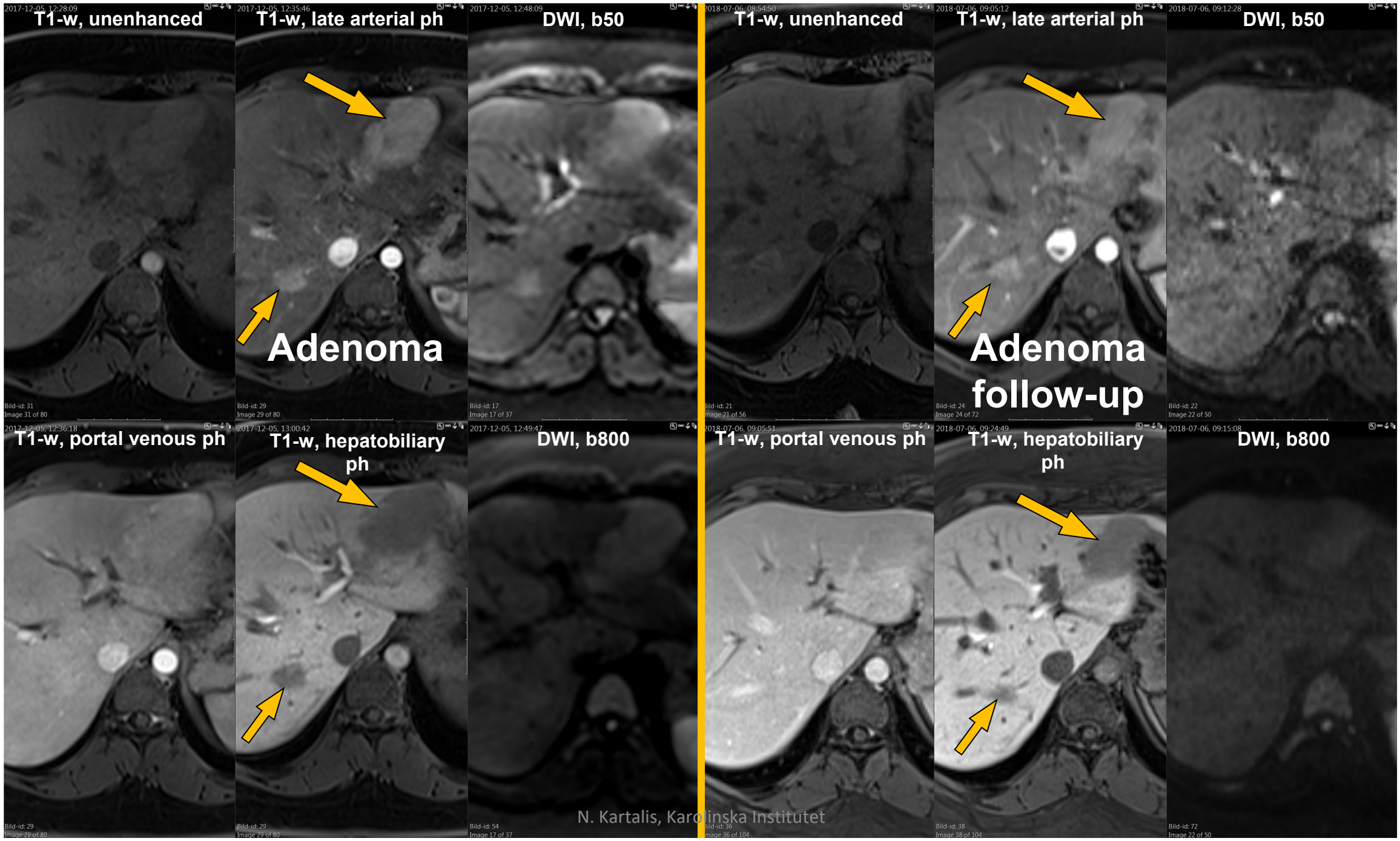
  - Take-home

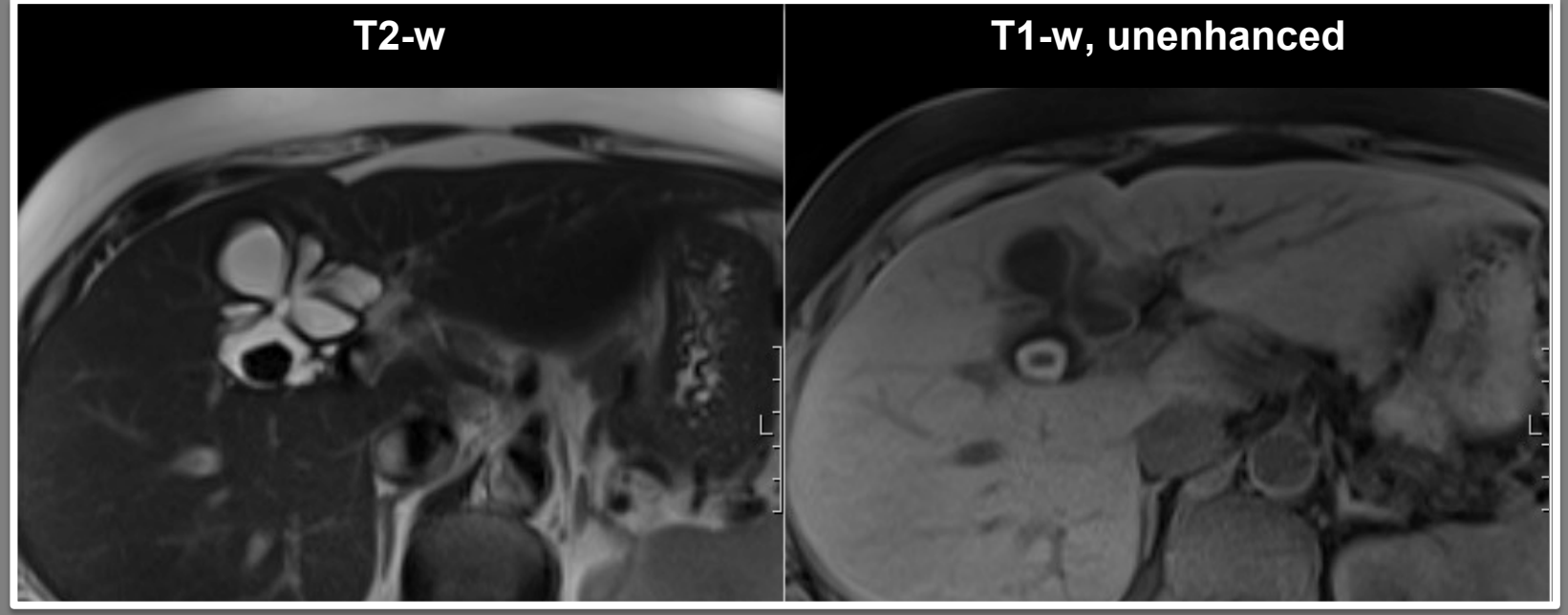
- FNH vs. adenoma
  - ➢ FNH: ↑/– HPB



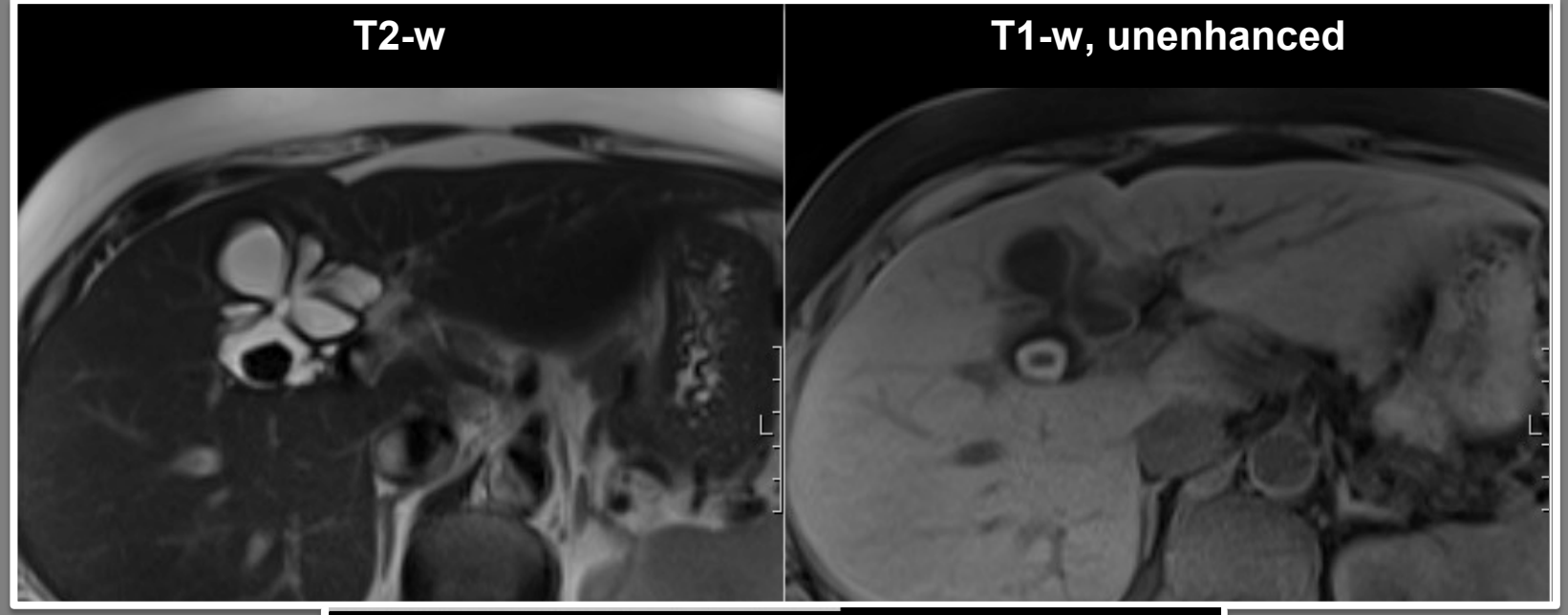


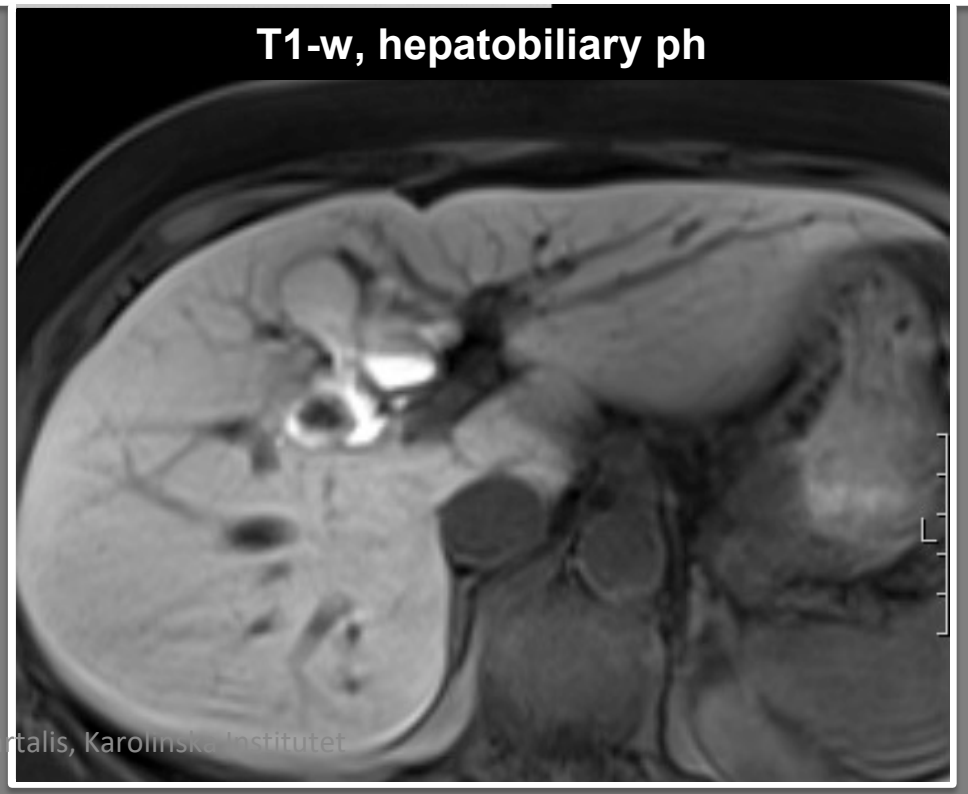


- Connex with bile ducts



- Connex with bile ducts
  - ➢ Bile duct cyst





Outline

- Lecture
  - Mechanism of action
  - ***Added value in characterization: malignant***
  - Pitfalls and limitations
- Case-based interactive discussion
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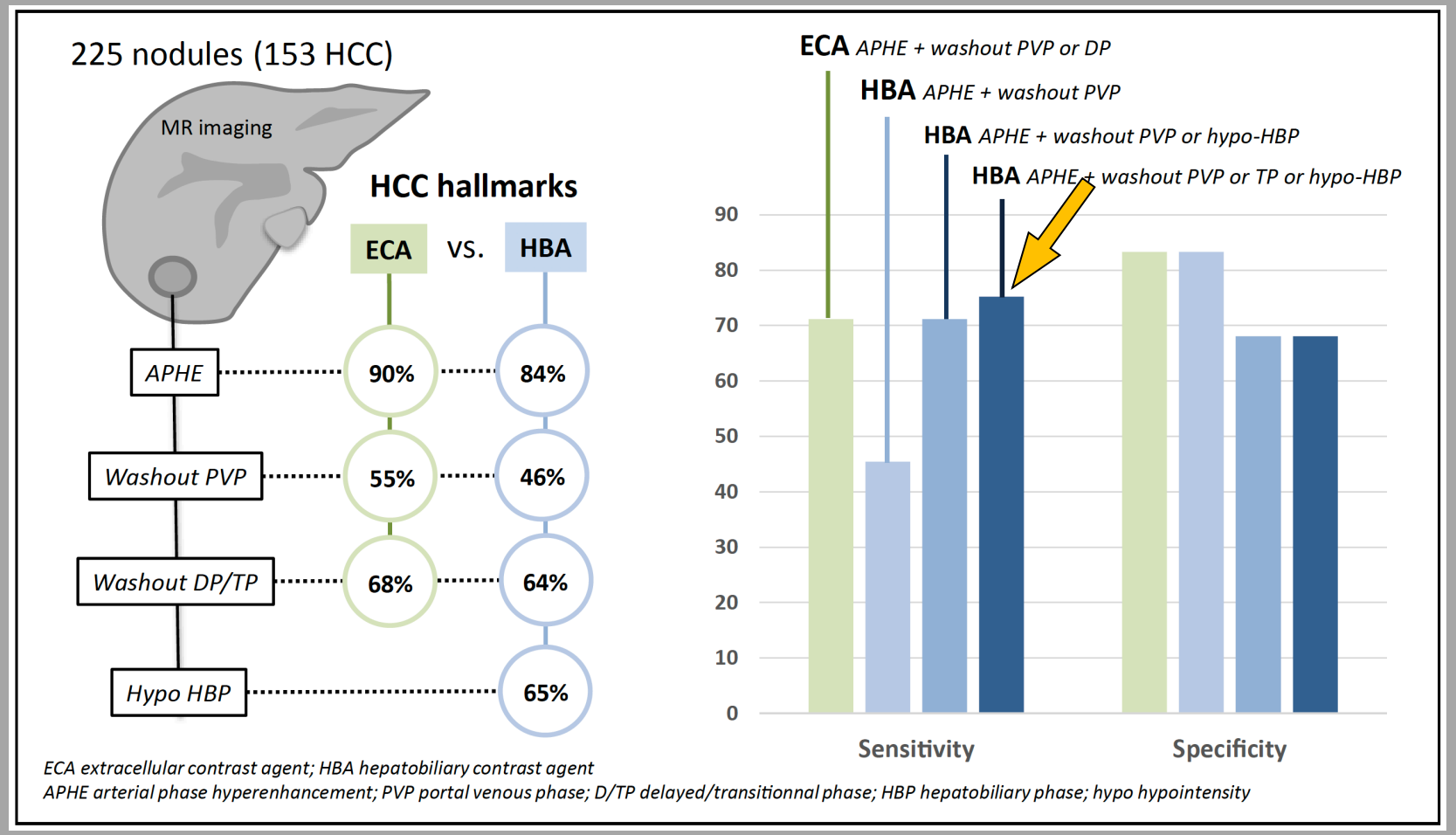
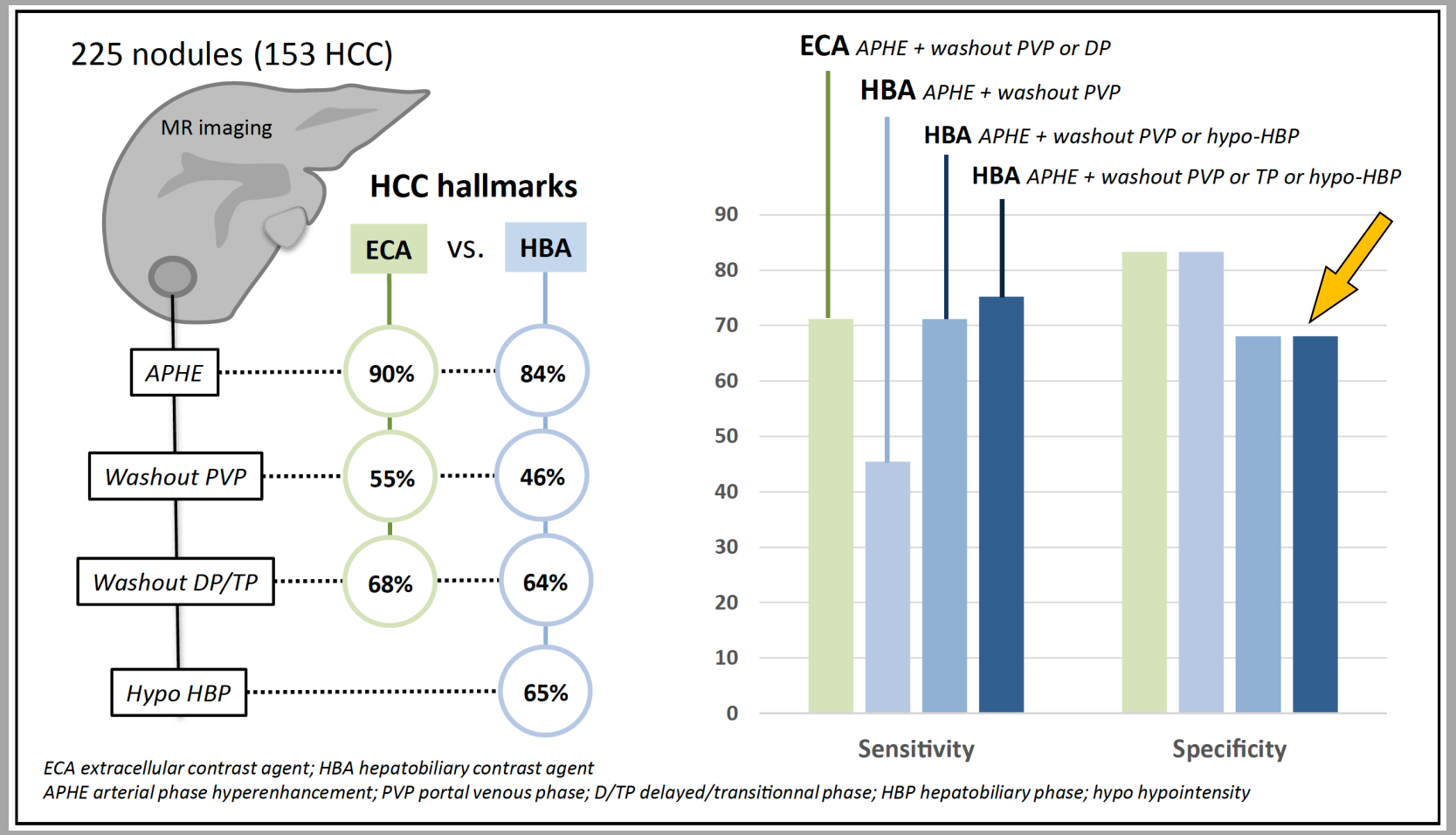
- HCC improved sens.
  - ➢ Absence of hep. function



[1]**Paisant A, et al.** Comparison of extracellular and hepatobiliary MR contrast agents for the diagnosis of small HCCs. **J Hepatol. 2020**

- HCC improved sens.
  - ➢ Absence of hep. function
  - ➢ Specificity: beware!



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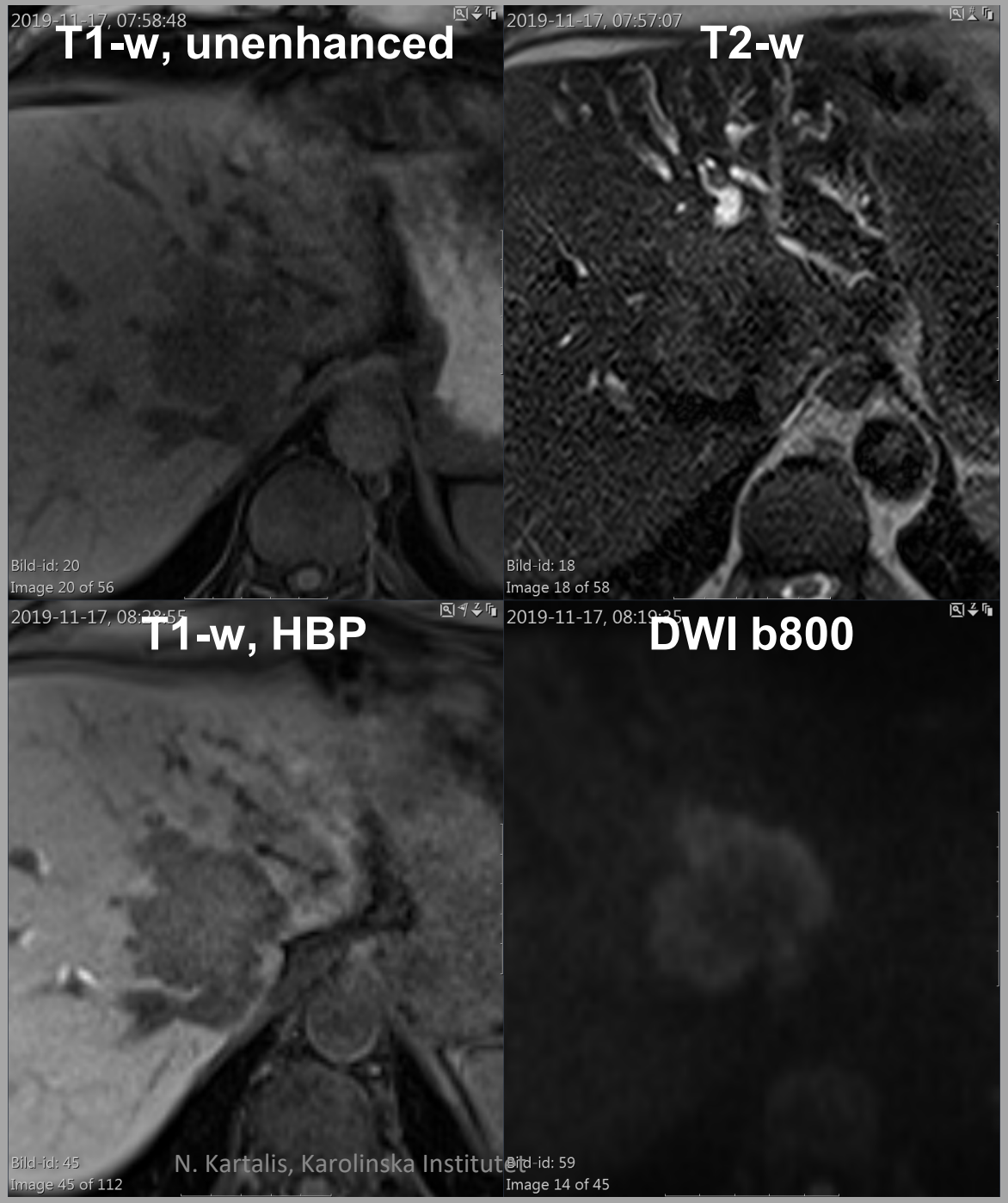
- HCC vs.

➢ CCC @ DWI & HBP → targetoid appearance



- HCC microvascular invasion

- HCC microvascular invasion→recurrence

- HCC microvascular invasion→recurrence

➢ Transplantation

European Radiology
https://doi.org/10.1007/s00330-019-06424-0

GASTROINTESTINAL

Gadoxetic acid–enhanced MRI as a predictor of recurrence of HCC after liver transplantation

Sunyoung Lee[1,2] · Kyoung Won Kim[2] · Woo Kyoung Jeong[3] · Myeong-Jin Kim[1] · Gi Hong Choi[4] · Jin Sub Choi[4] · Gi-Won Song[5] · Sung-Gyu Lee[5]

- HCC microvascular invasion→recurrence
  - ➢ Transplantation
  - ➢ Resection

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GASTROINTESTINAL

Check for updates

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Research Article

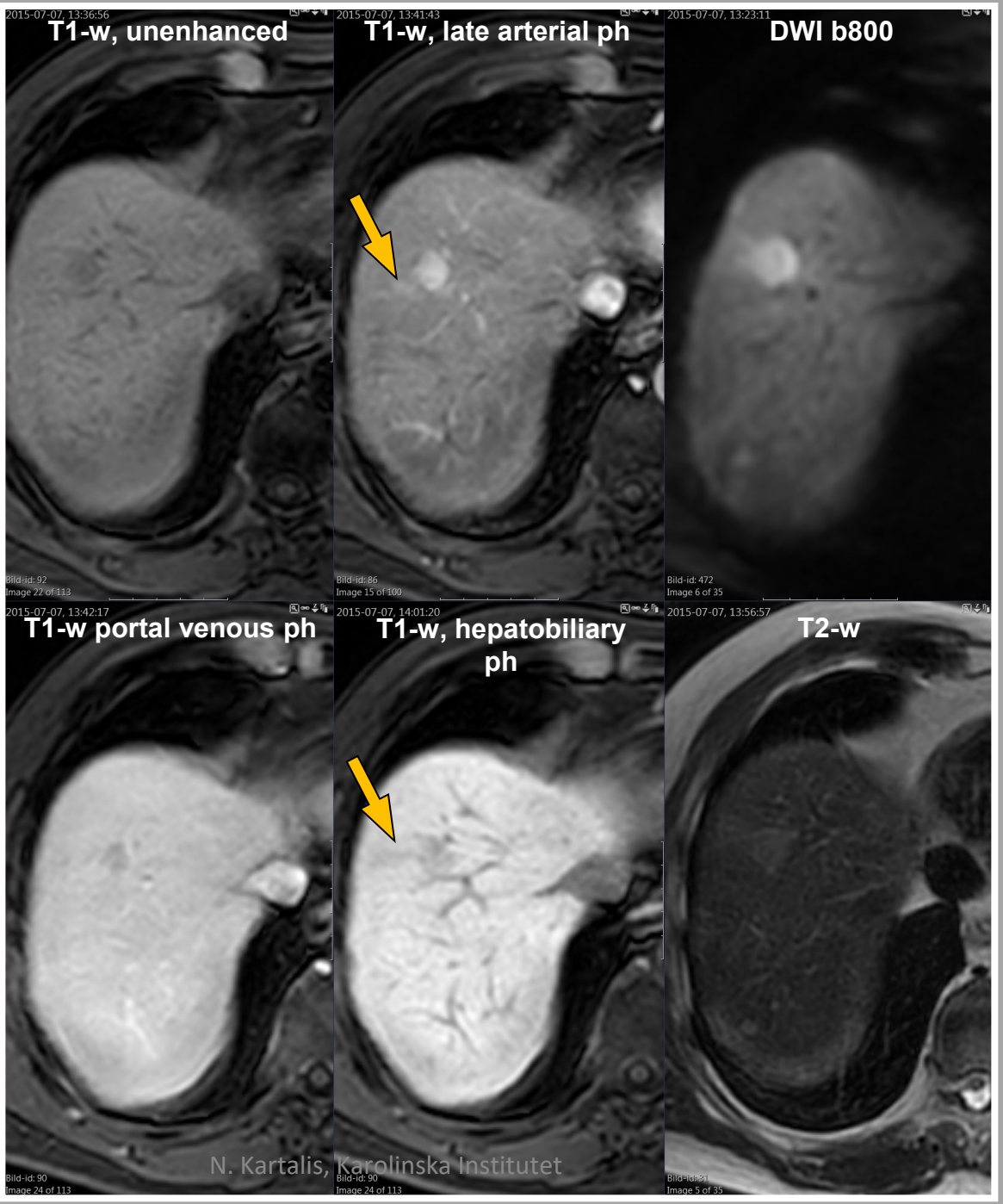
CrossMark

EASL JOURNAL OF HEPATOLOGY

Preoperative gadoxetic acid–enhanced MRI for predicting microvascular invasion in patients with single hepatocellular carcinoma

Sunyoung Lee[1], Seong Hyun Kim[1,*], Ji Eun Lee[1], Dong Hyun Sinn[2], Cheol Keun Park[3]

- HCC microvascular invasion→recurrence
  - ➢ Transplantation
  - ➢ Resection



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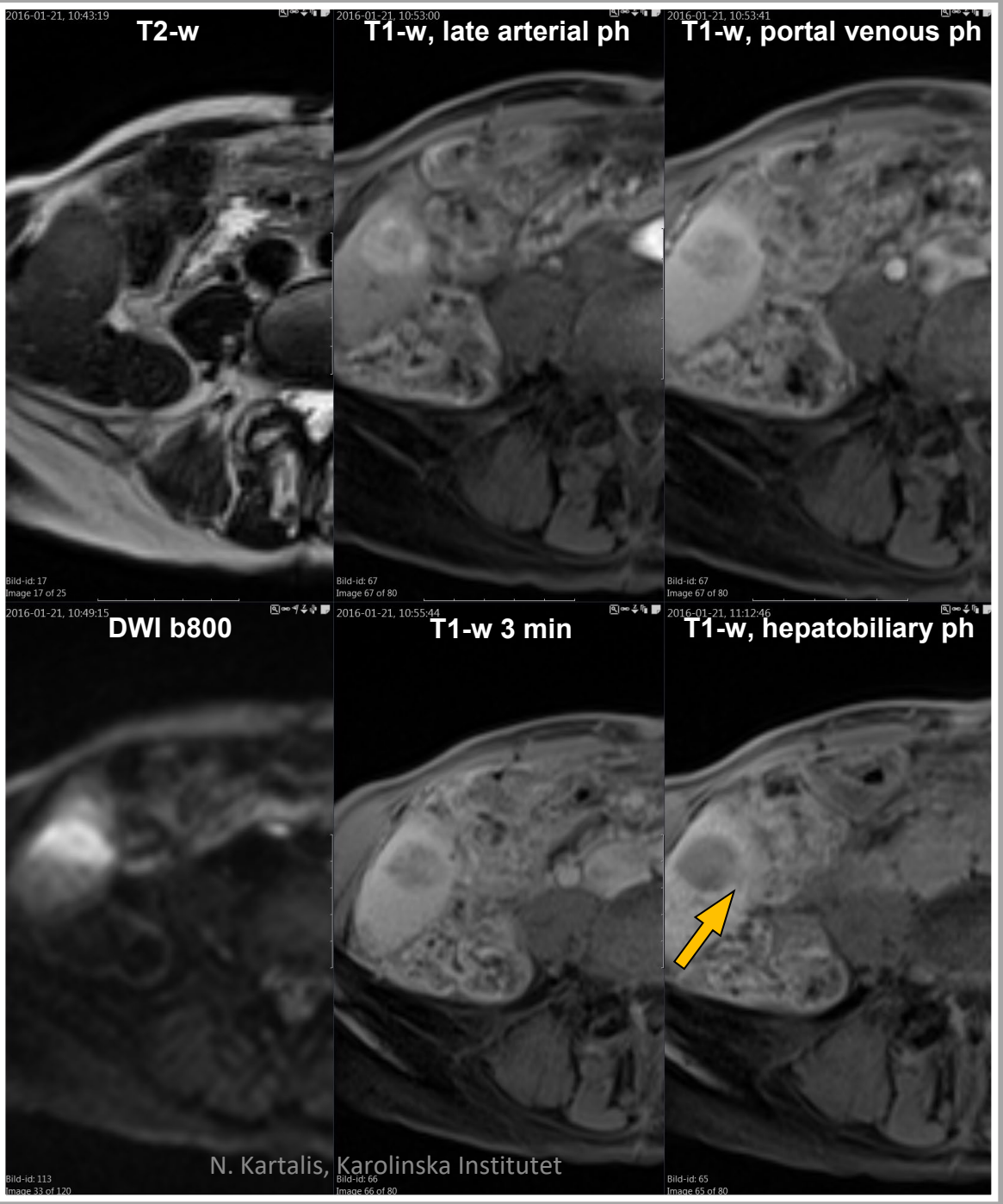

- CRLM→ response to chemotherapy

➢ Relative tumour enhancement @ HBP >25%

Abdominal Radiology

Published online: 17 April 2018

Abdom Radiol (2018) 43:3301–3306
https://doi.org/10.1007/s00261-018-1615-z

Predicting chemotherapeutic response for colorectal liver metastases using relative tumor enhancement of gadoxetic acid disodium-enhanced magnetic resonance imaging

Shinichi Murata[1], Shigeru Matsushima,[1] Yozo Sato,[1] Hidekazu Yamaura,[1] Mina Kato,[1] Takaaki Hasegawa,[1] Kei Muro,[2] Yoshitaka Inaba[1]

- CRLM→ response to chemotherapy

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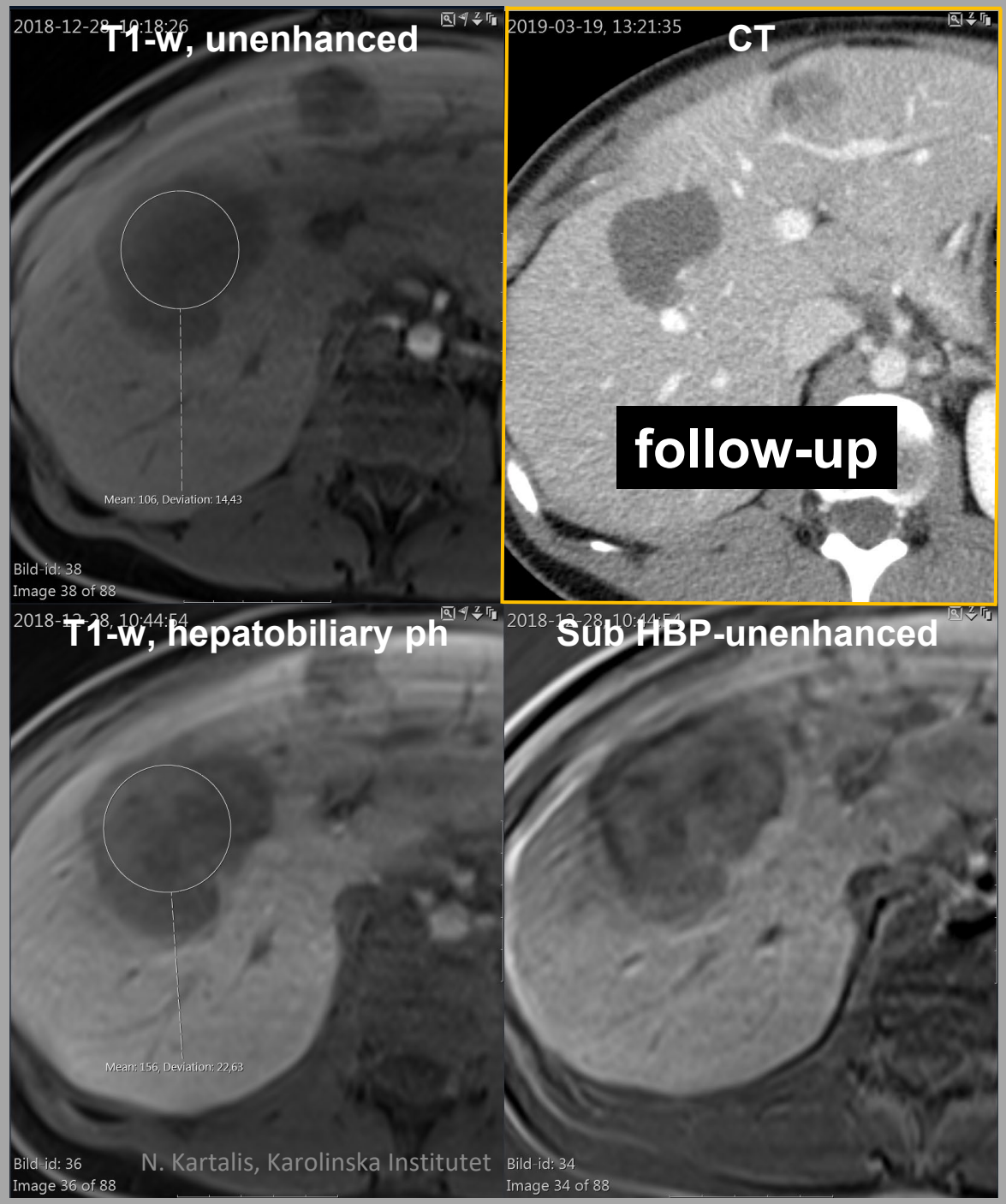

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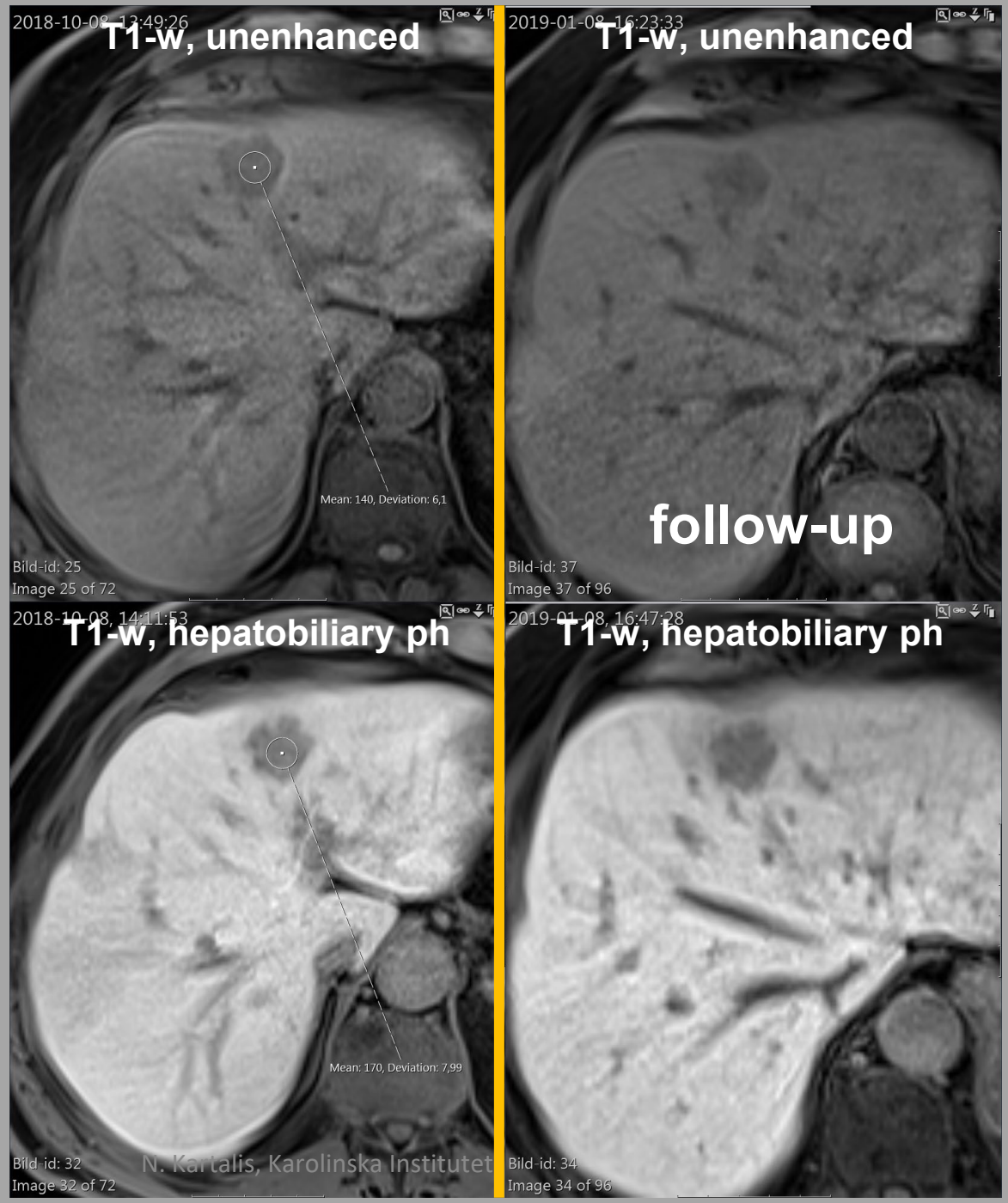

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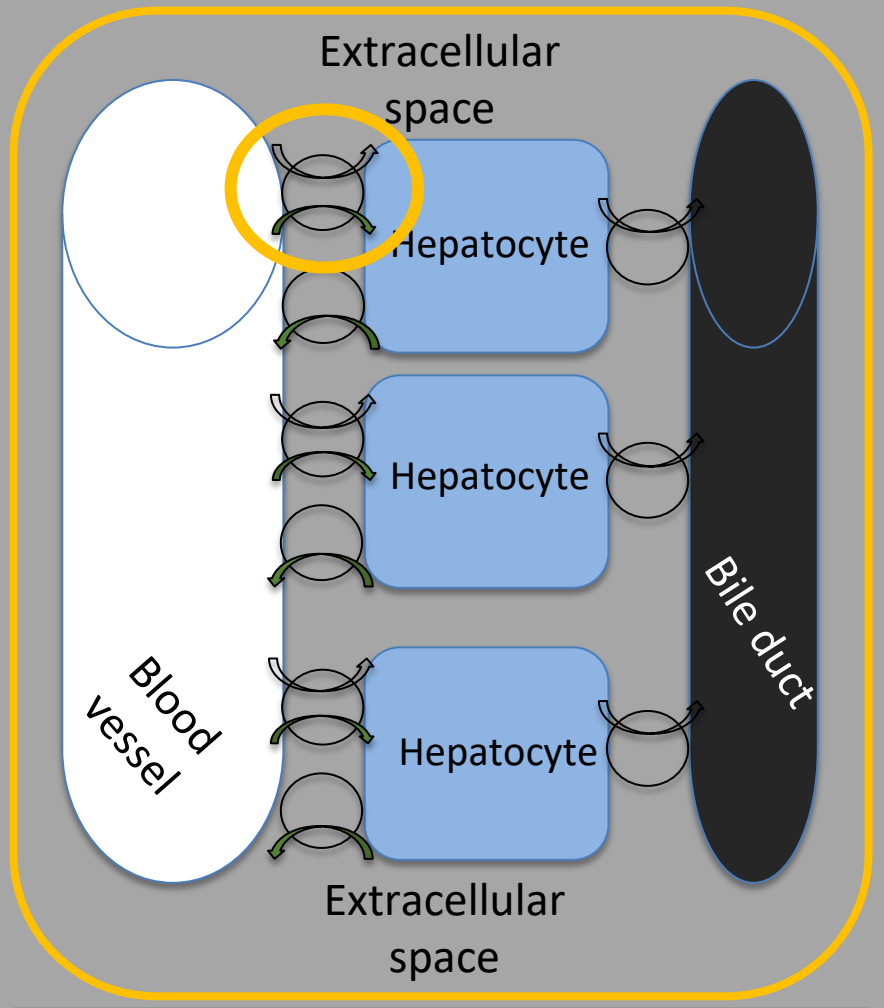
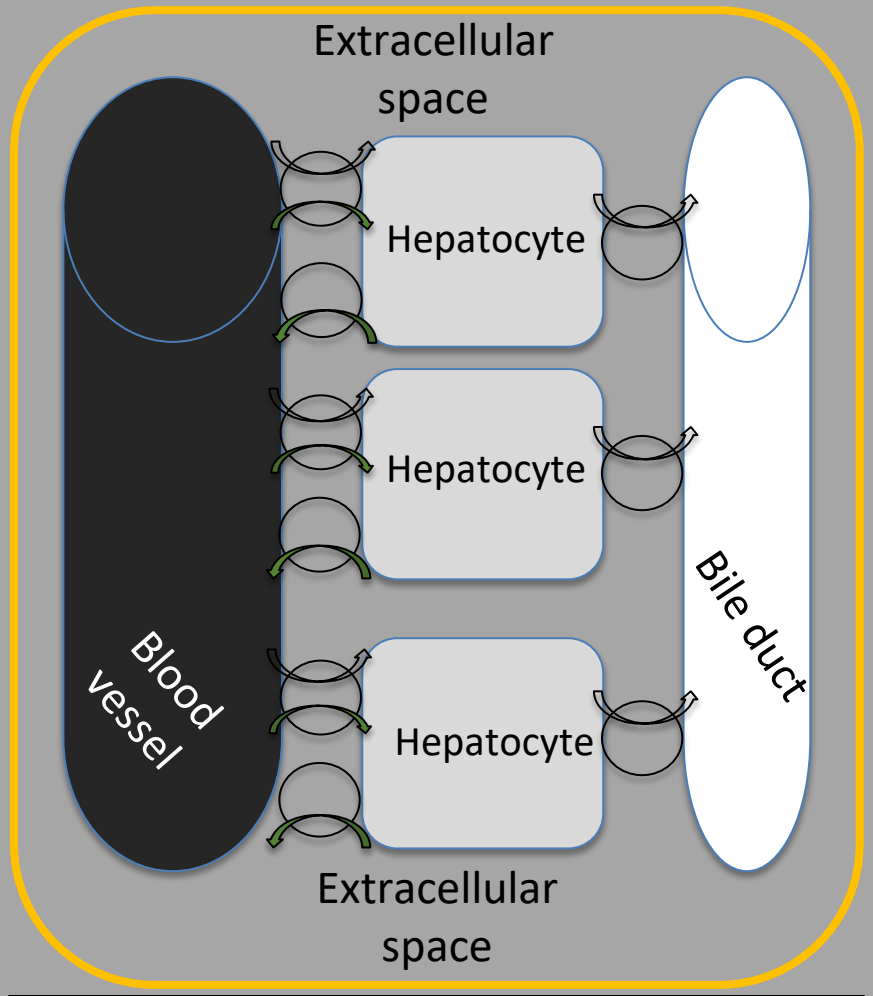
  - Mechanism of action
  - Added value in characterization
  - ***Pitfalls and limitations 1***
- Case-based interactive discussion
  - Take-home

- Delay/absence
  - ➢ Severe cholestasis
  - ➢ Liver failure

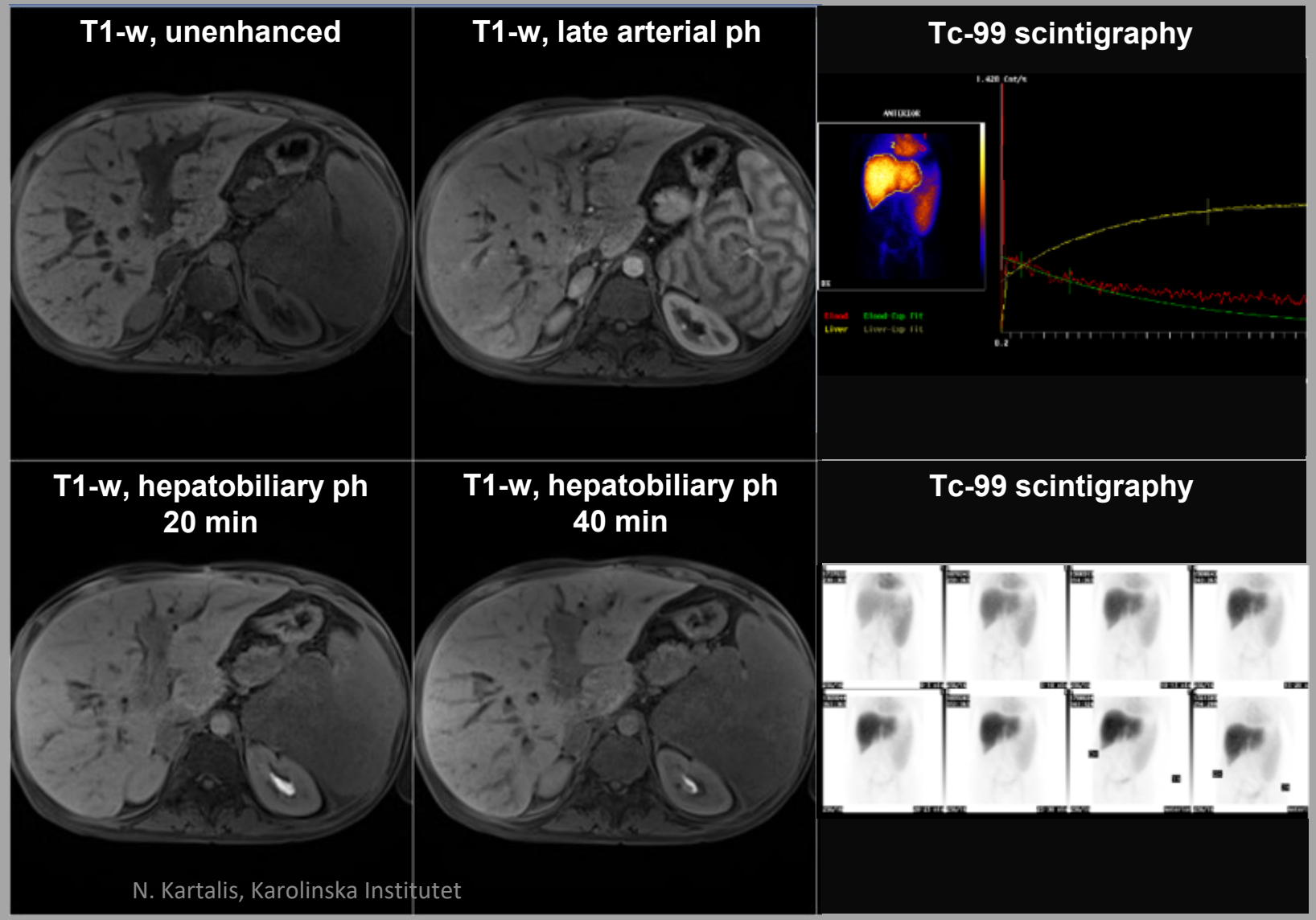


Vascular ph

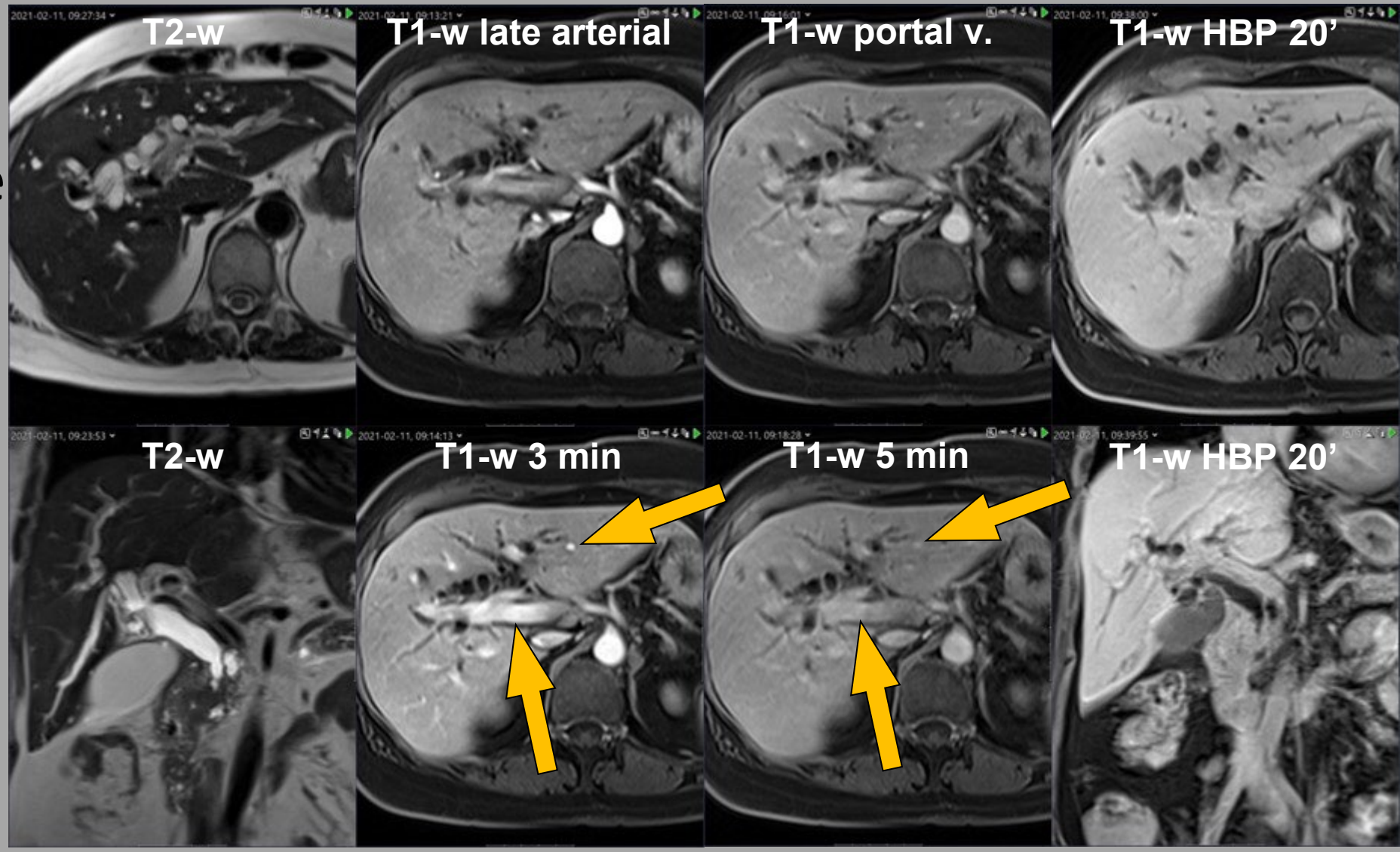


Hepatobiliary ph

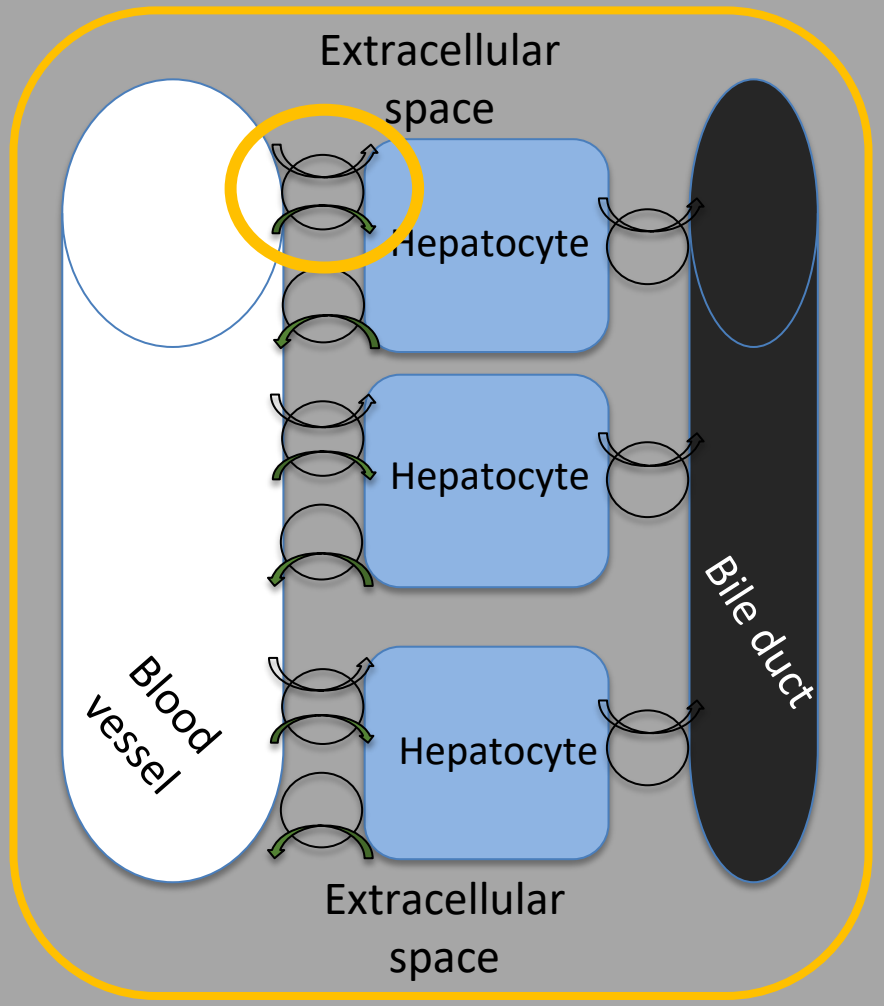
- Delay/absence
  - ➢ Severe cholestasis
  - ➢ Liver failure



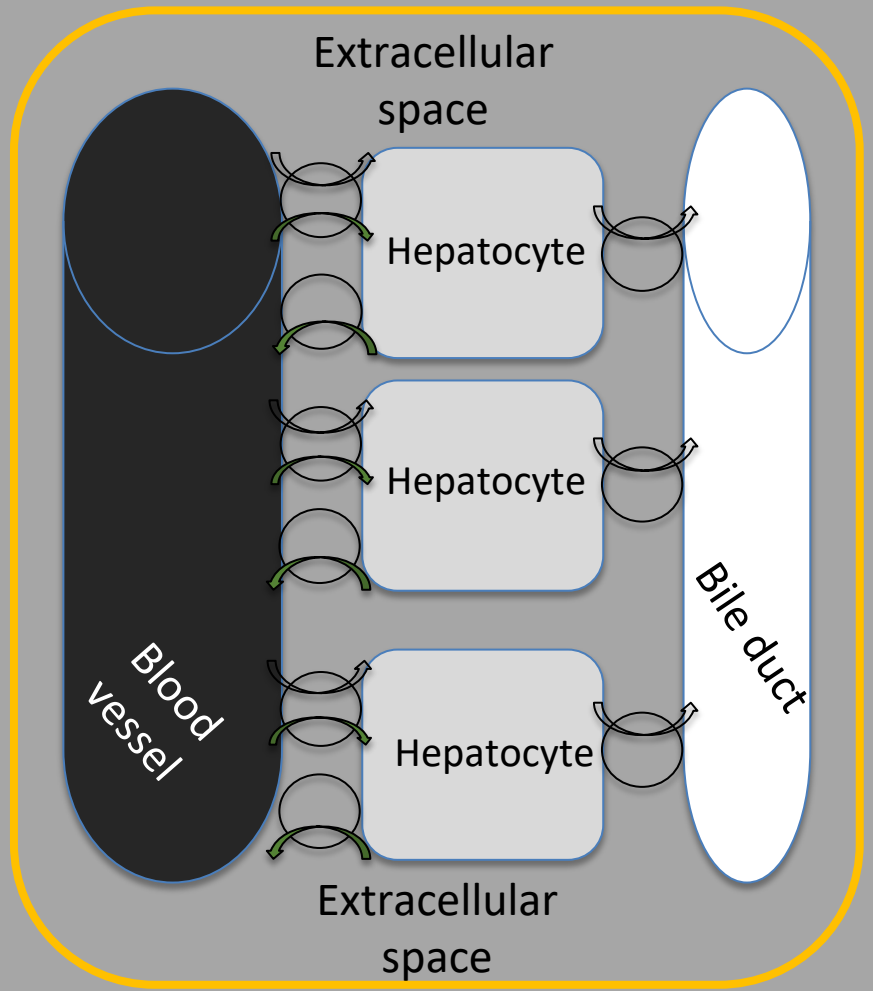
- Delay/absence
  - ➢ Severe cholestasis
  - ➢ Liver failure



- Delay/absence
  - Severe cholestasis
  - Liver failure
- Bilirubin
  - To test or not to test?
  - >3 mg/dL

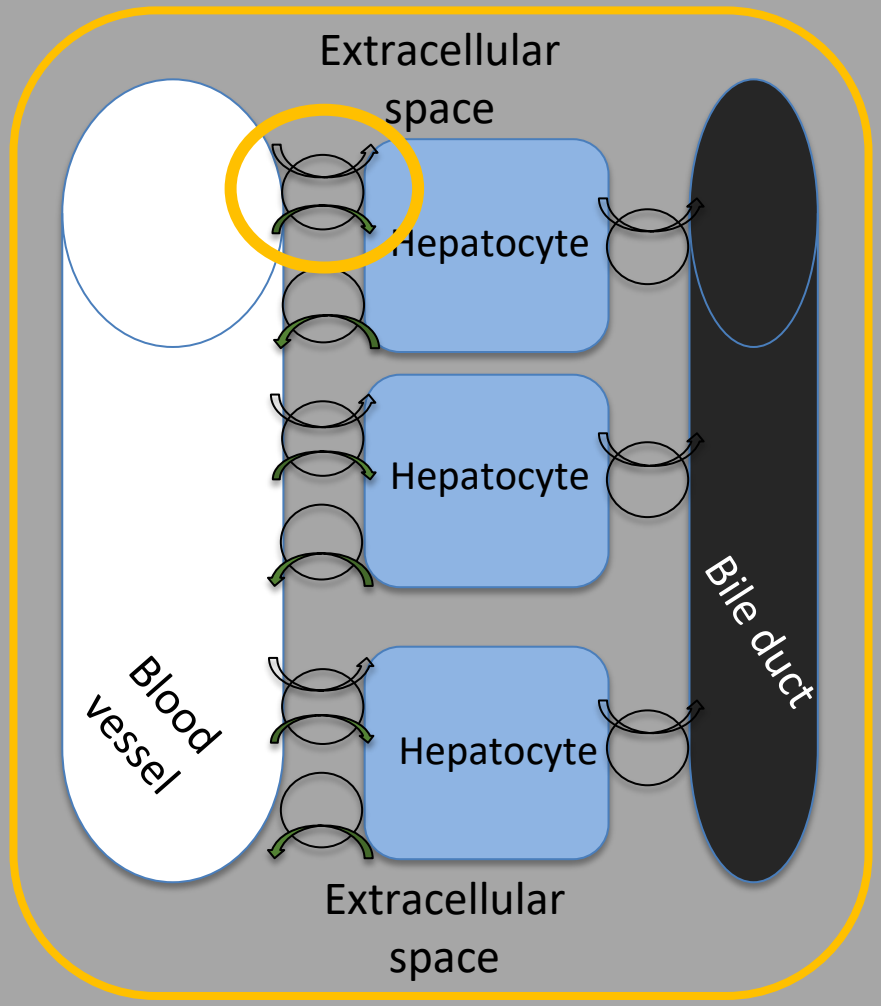


Vascular ph

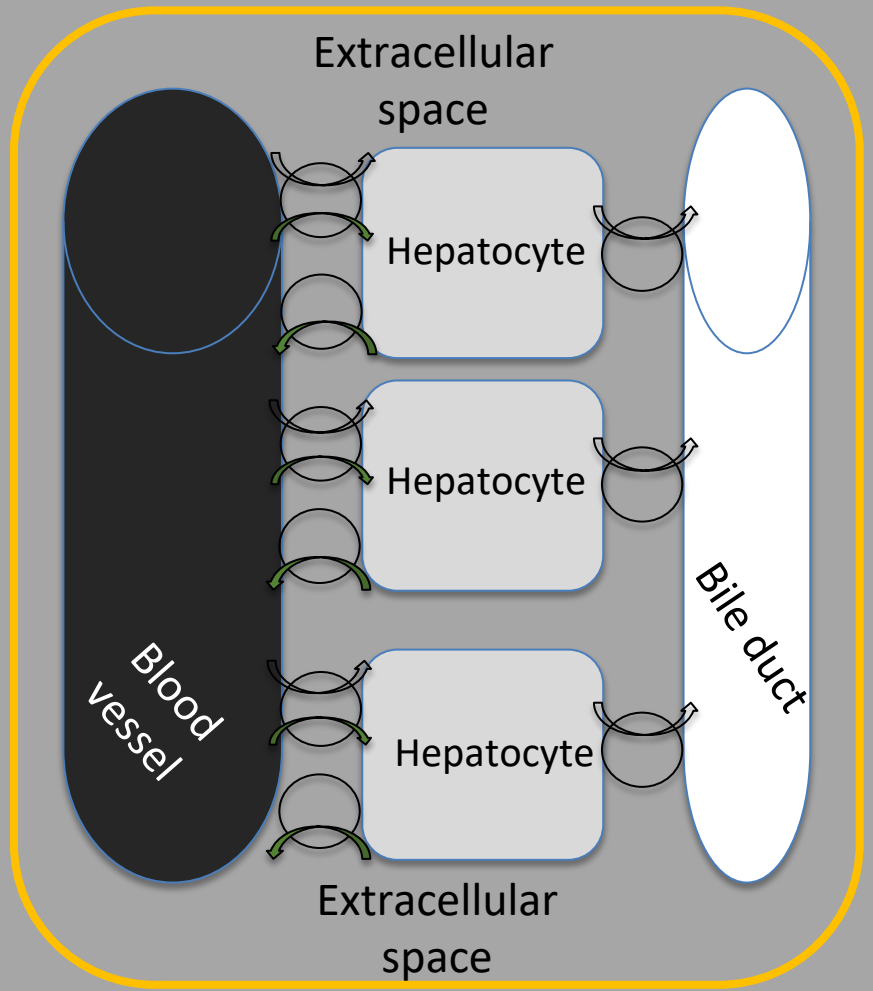


Hepatobiliary ph

- Delay/absence
  - Severe cholestasis
  - Liver failure
- Bilirubin
  - To test or not to test?
  - >3 mg/dL
  - Drainage!



Vascular ph



Hepatobiliary ph

Outline

- Lecture
  - Mechanism of action
  - Added value in characterization
  - ***Pitfalls and limitations 2***
- Case-based interactive discussion
  - Take-home

“Weak” arterial phase

- Primovist (1/4 dose Gd/kg BW vs. EC-CA)

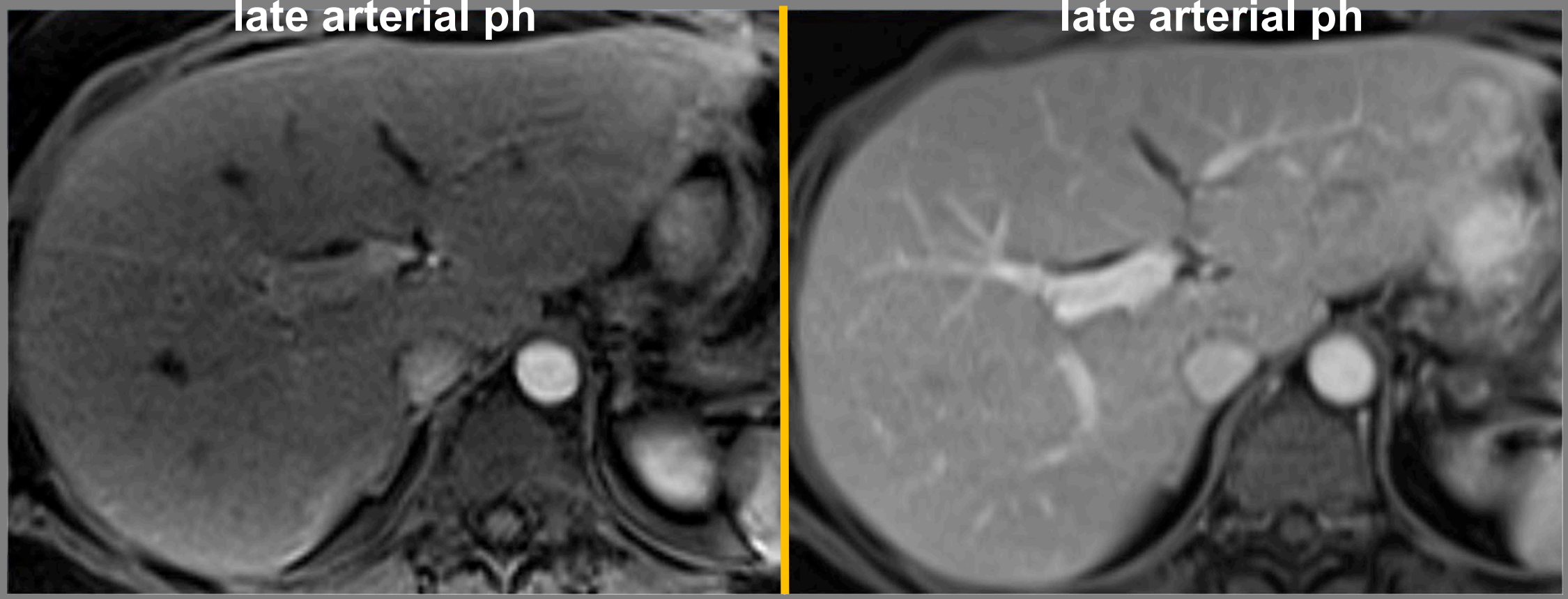
Acta Radiol. 2009 Sep;50(7):709-15. doi: 10.1080/02841850903055603.

Liver vessel enhancement by Gd-BOPTA and Gd-EOB-DTPA: a comparison in healthy volunteers.

Brismar TB[1], Dahlstrom N, Edsborg N, Persson A, Smedby O, Albiin N.

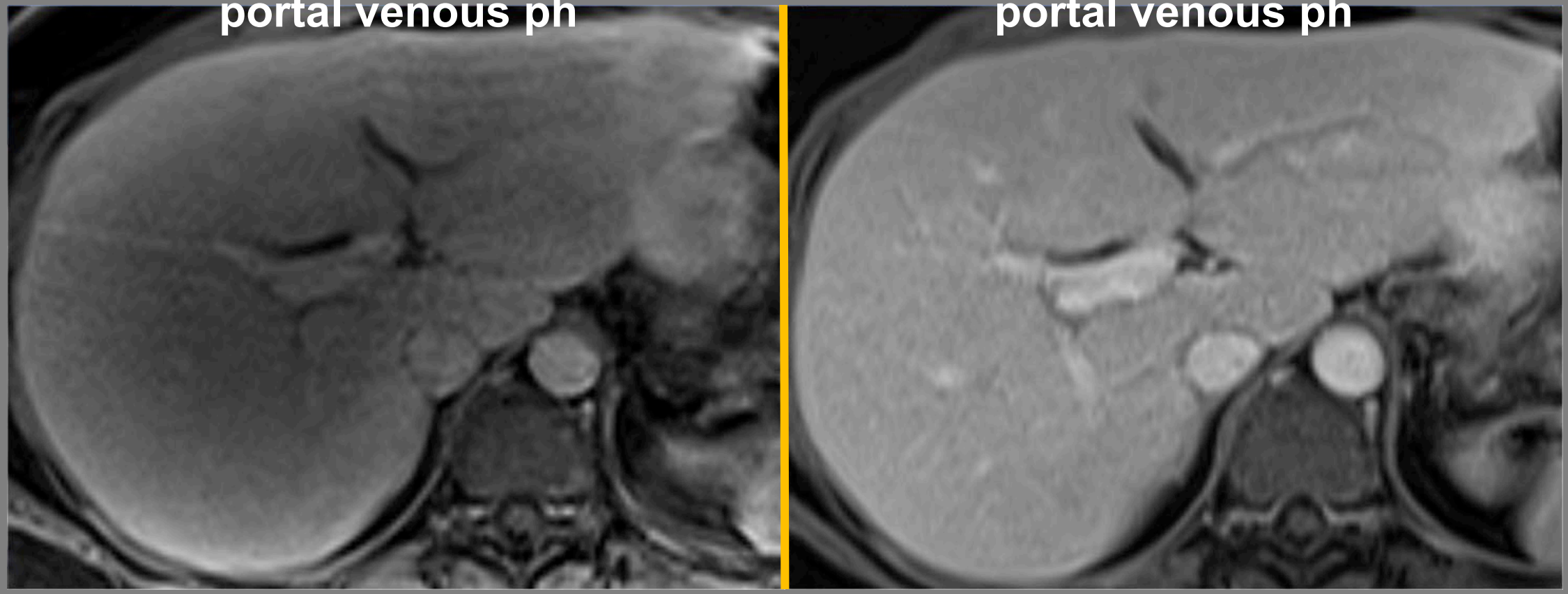
Occasion A

Occasion B



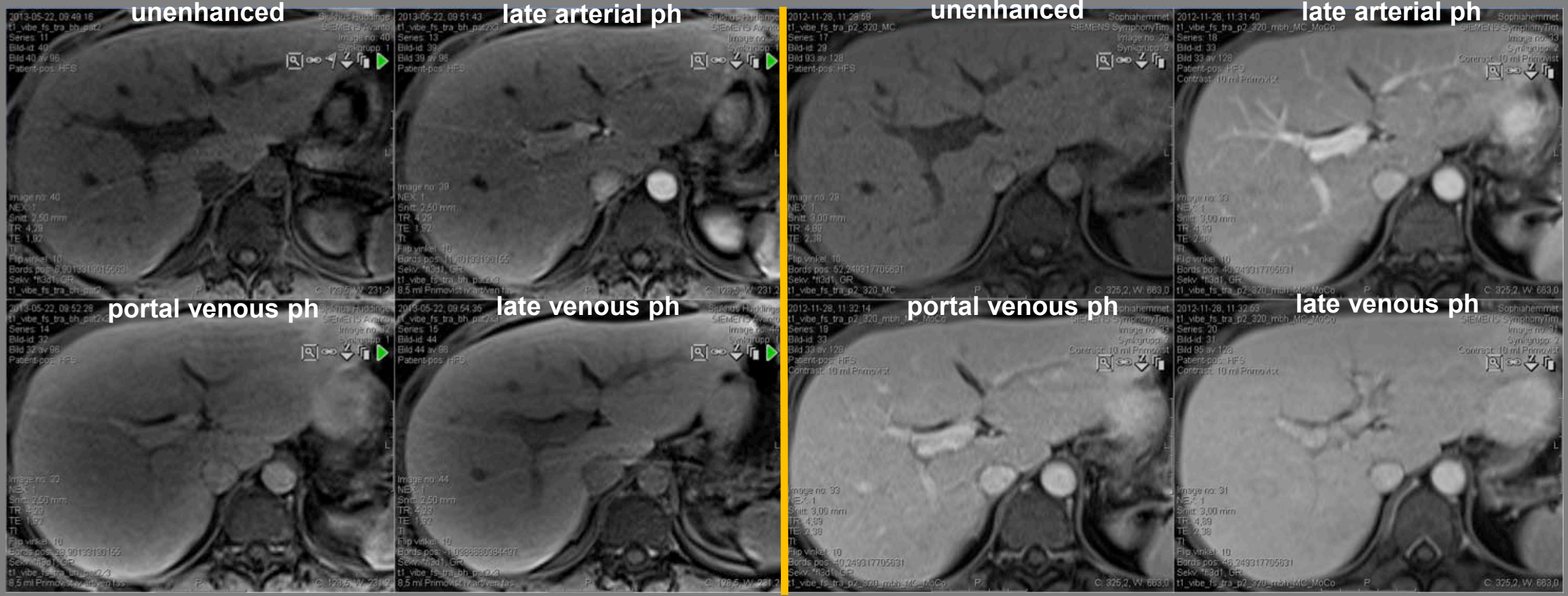
Occasion A

Occasion B



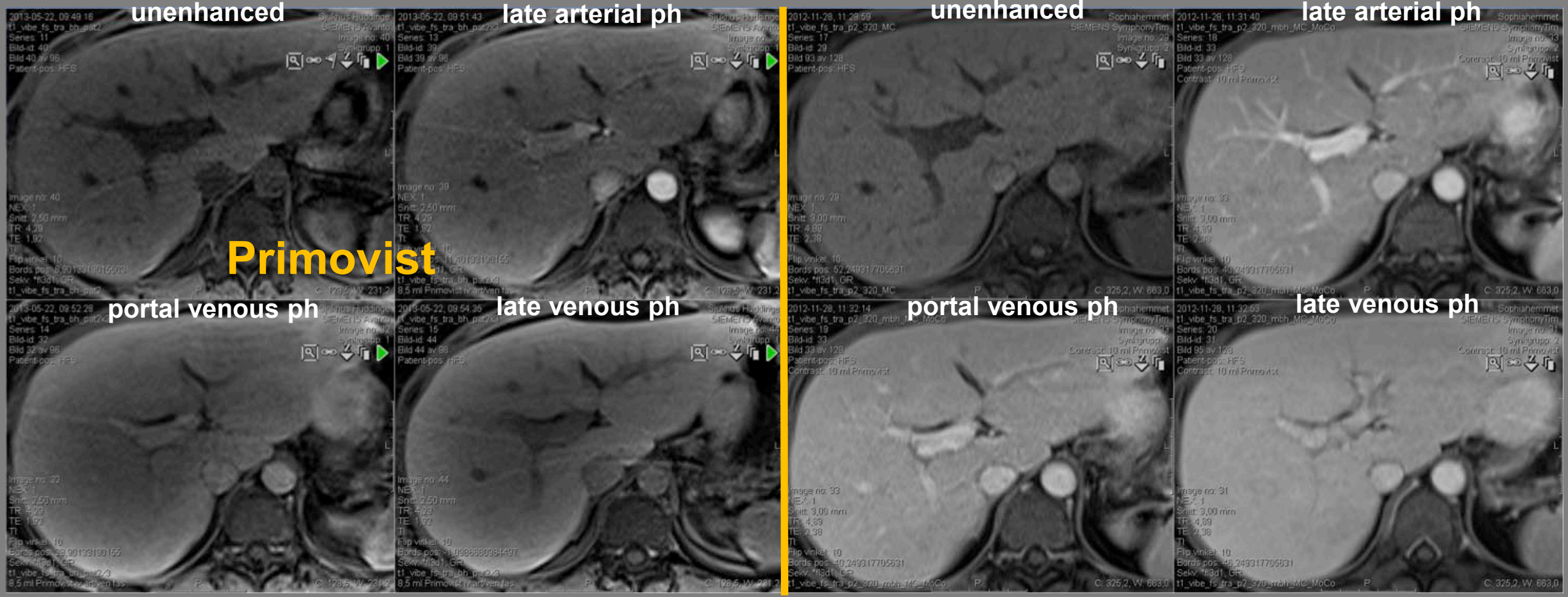
Occasion A

Occasion B



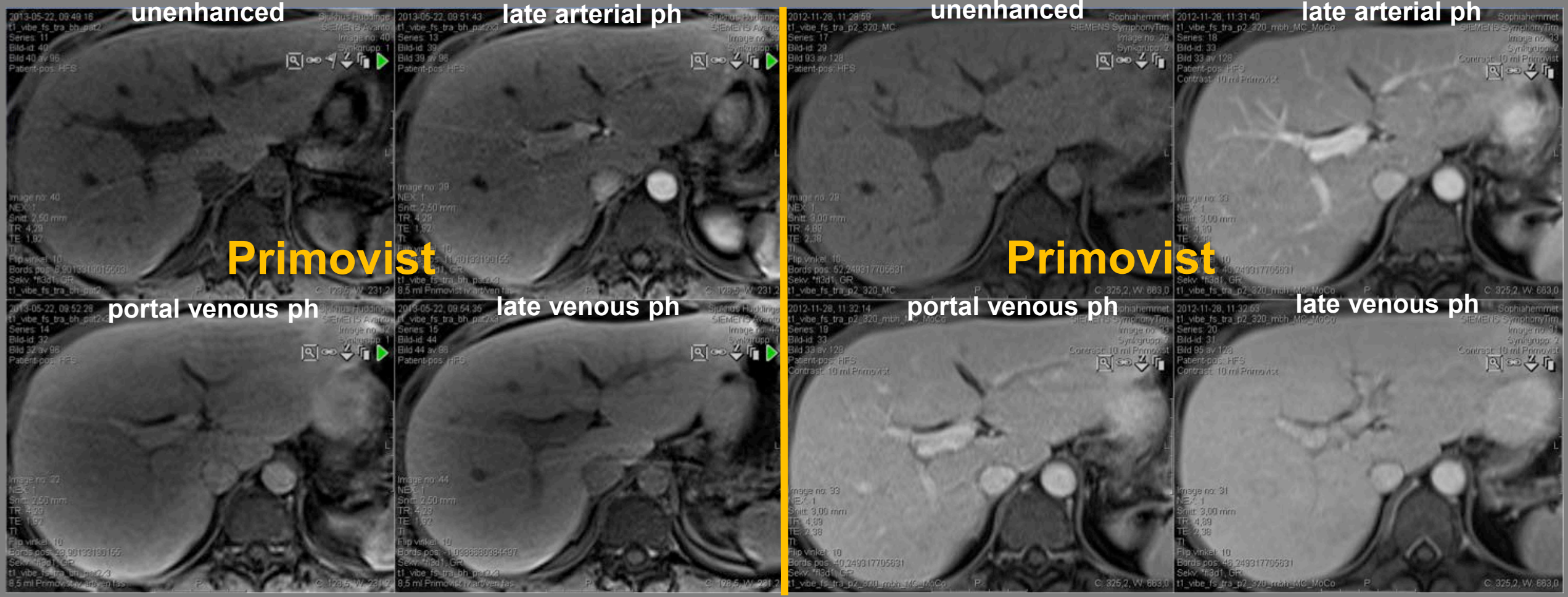
Occasion A

Occasion B



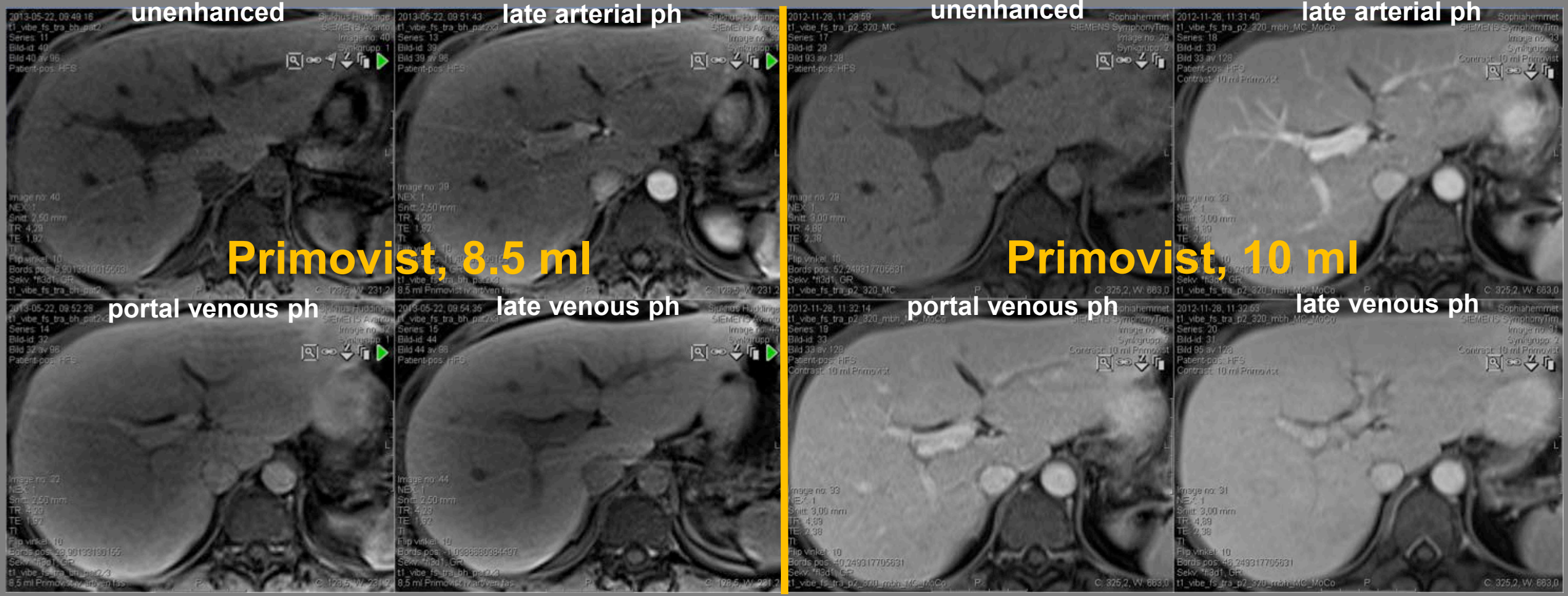
Occasion A

Occasion B



Occasion A

Occasion B



“Weak” arterial phase

- Primovist (1/4 dose Gd/kg BW vs. EC-CA)
- Suggestion
  - ↑ amount of IV contrast, e.g. 10 ml to all “flat-dose” 

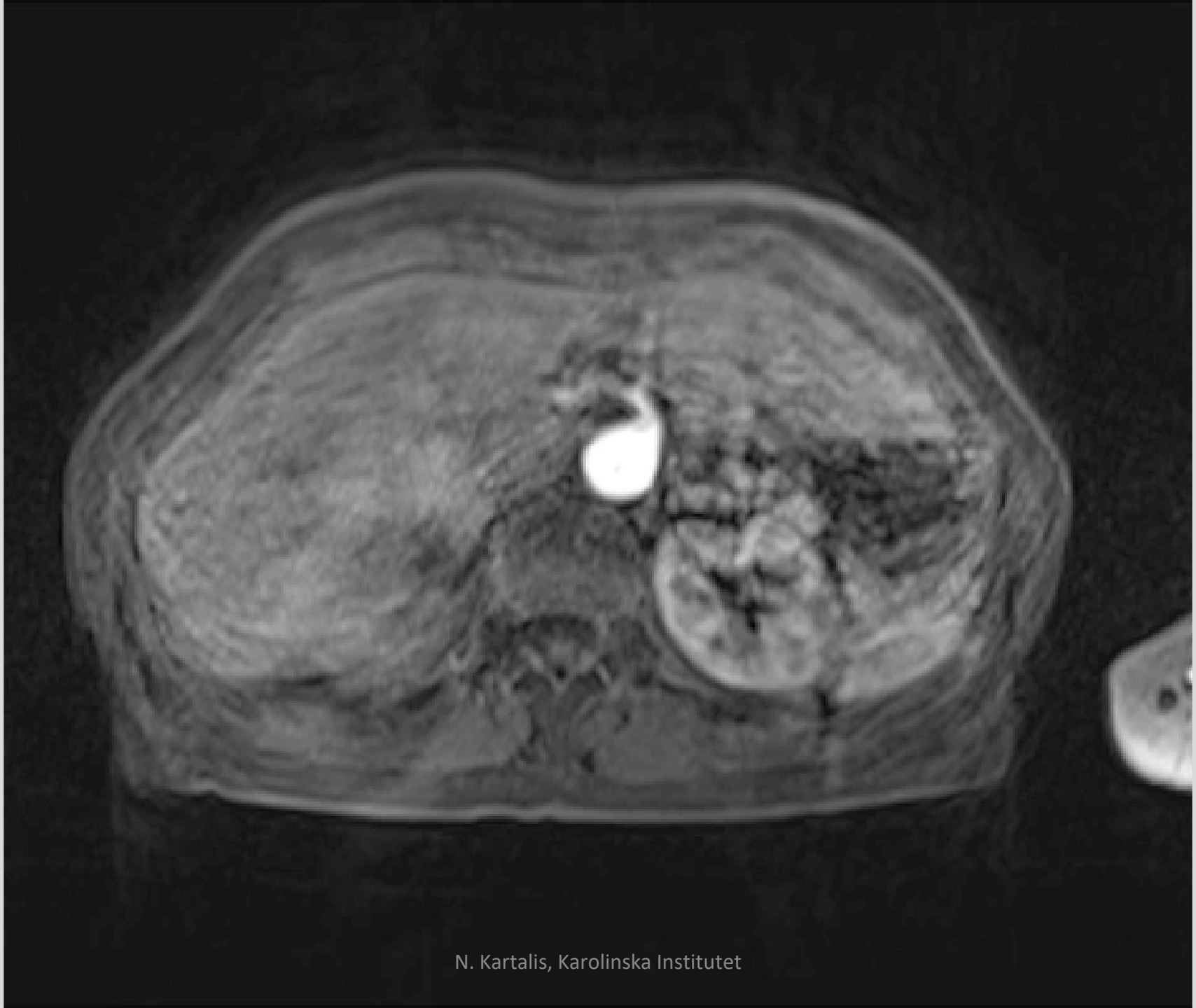
AJR Am J Roentgenol. 2010 Jul;195(1):13-28. doi: 10.2214/AJR.10.4392.

Gadoxetate disodium-enhanced MRI of the liver: part 1, protocol optimization and lesion appearance in the noncirrhotic liver.

Ringe KI[1], Husarik DB, Sirlin CB, Merkle EM.

Outline

- Lecture
  - Mechanism of action
  - Added value in characterization
  - ***Pitfalls and limitations 3***
- Case-based interactive discussion
  - Take-home



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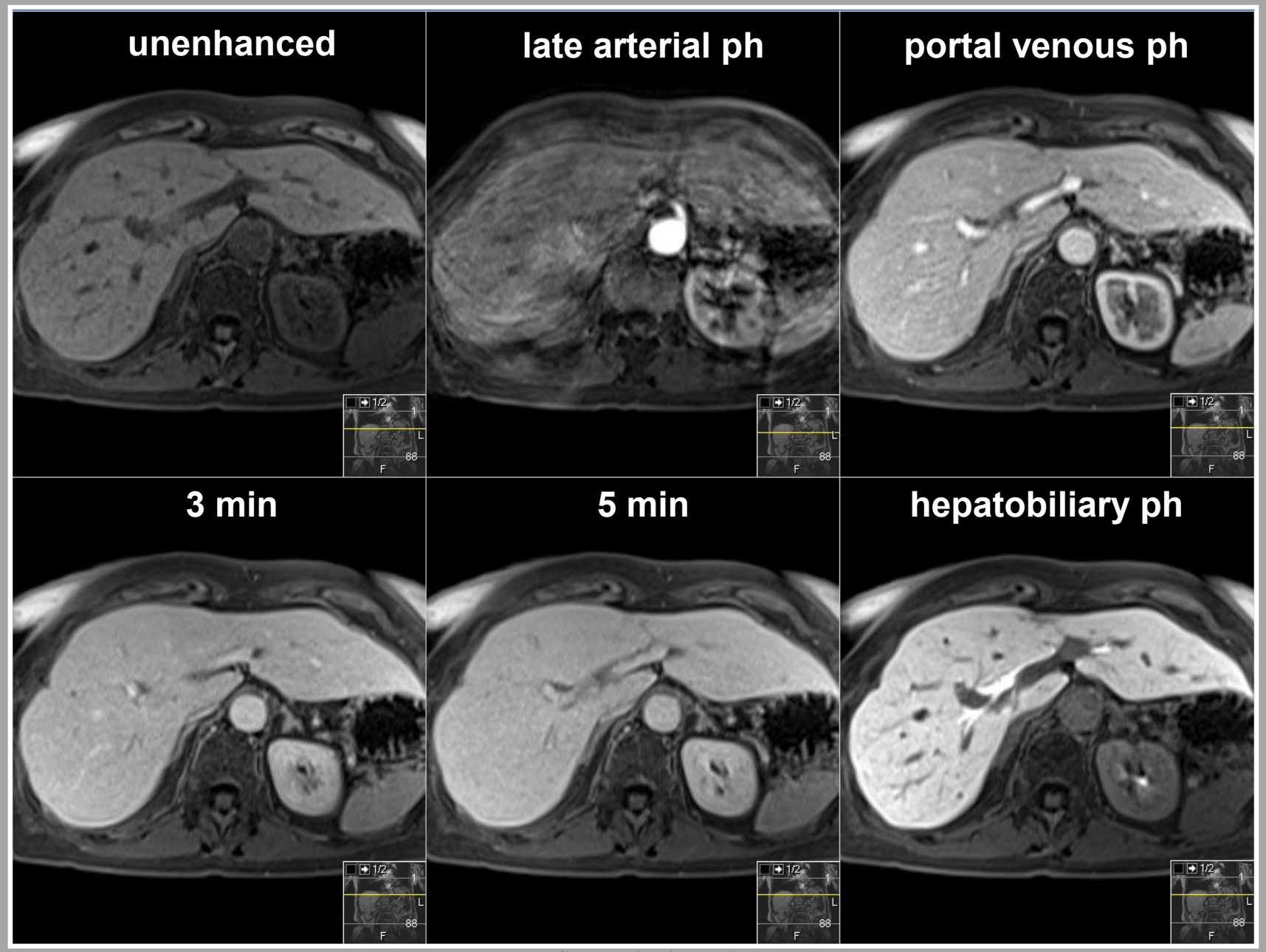
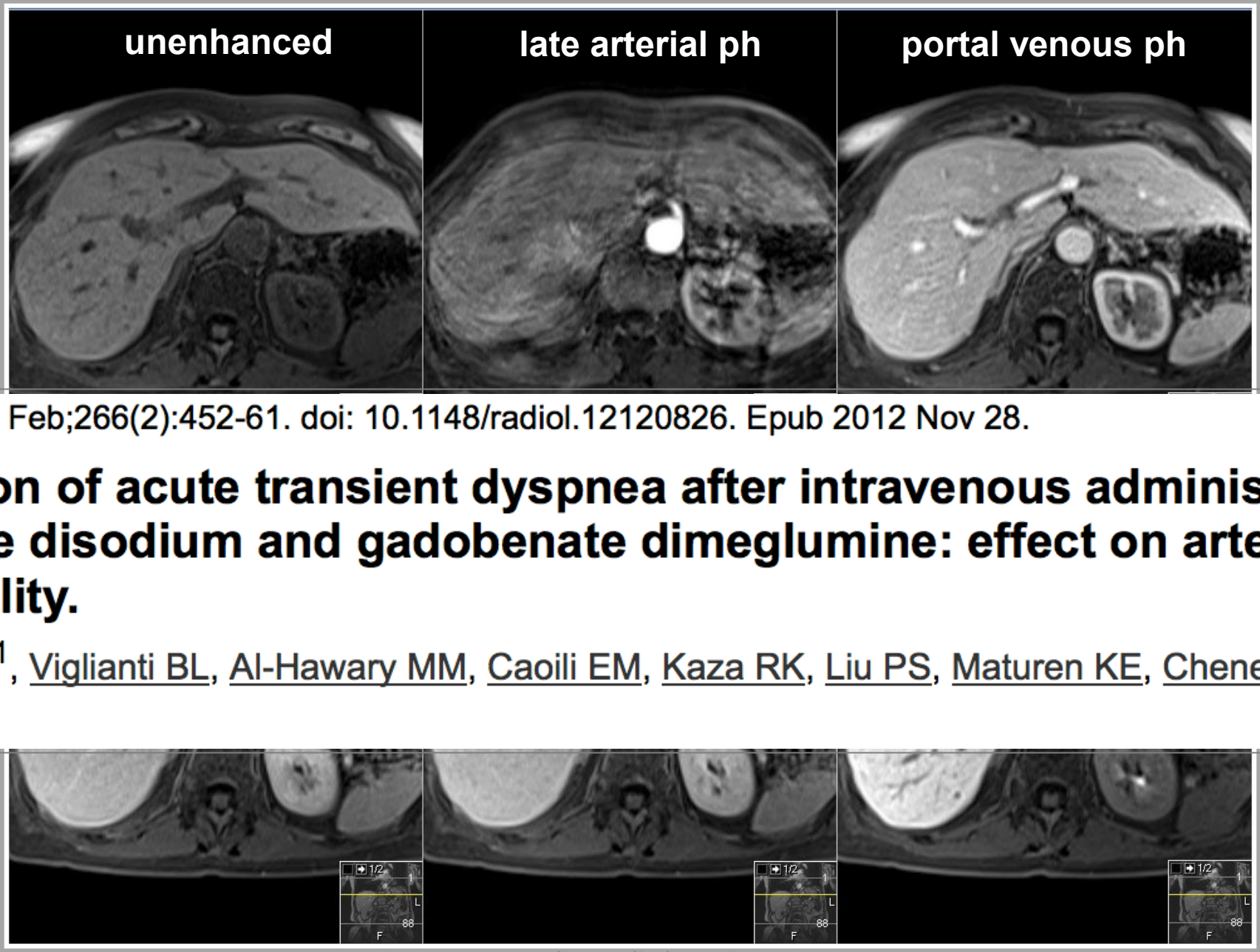
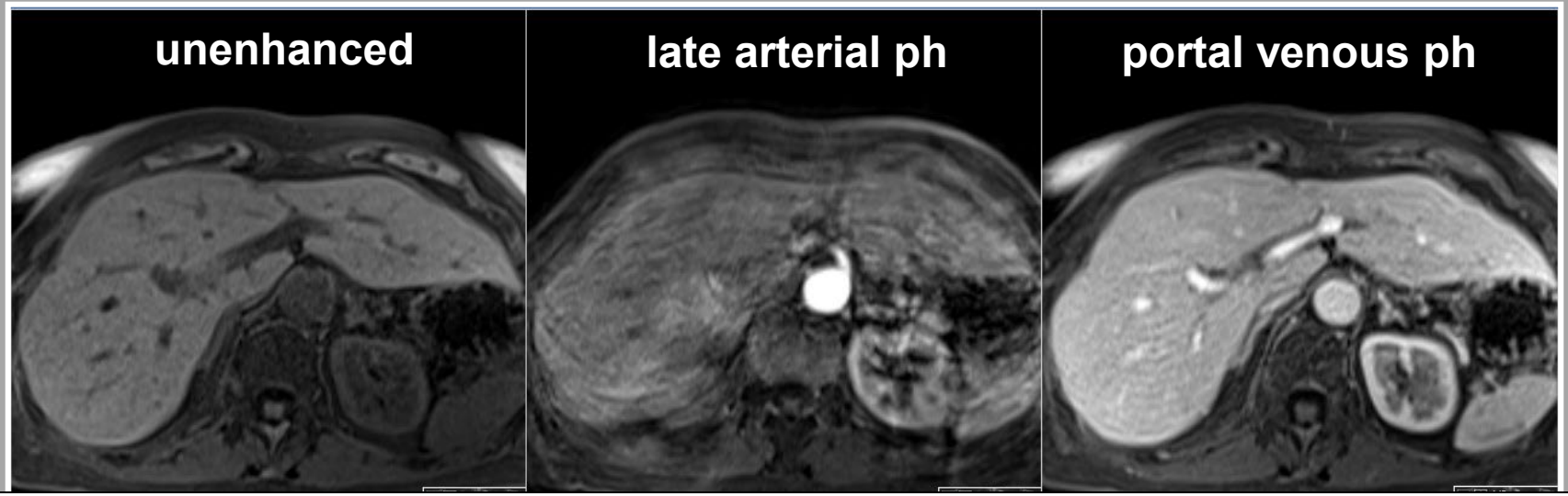

unenhanced
late arterial ph
portal venous ph
3 min
5 min
hepatobiliary ph



Radiology. 2013 Feb;266(2):452-61. doi: 10.1148/radiol.12120826. Epub 2012 Nov 28.

Comparison of acute transient dyspnea after intravenous administration of gadoxetate disodium and gadobenate dimeglumine: effect on arterial phase image quality.

Davenport MS[1], Viglianti BL, Al-Hawary MM, Caoili EM, Kaza RK, Liu PS, Maturen KE, Chenevert TL, Hussain HK.



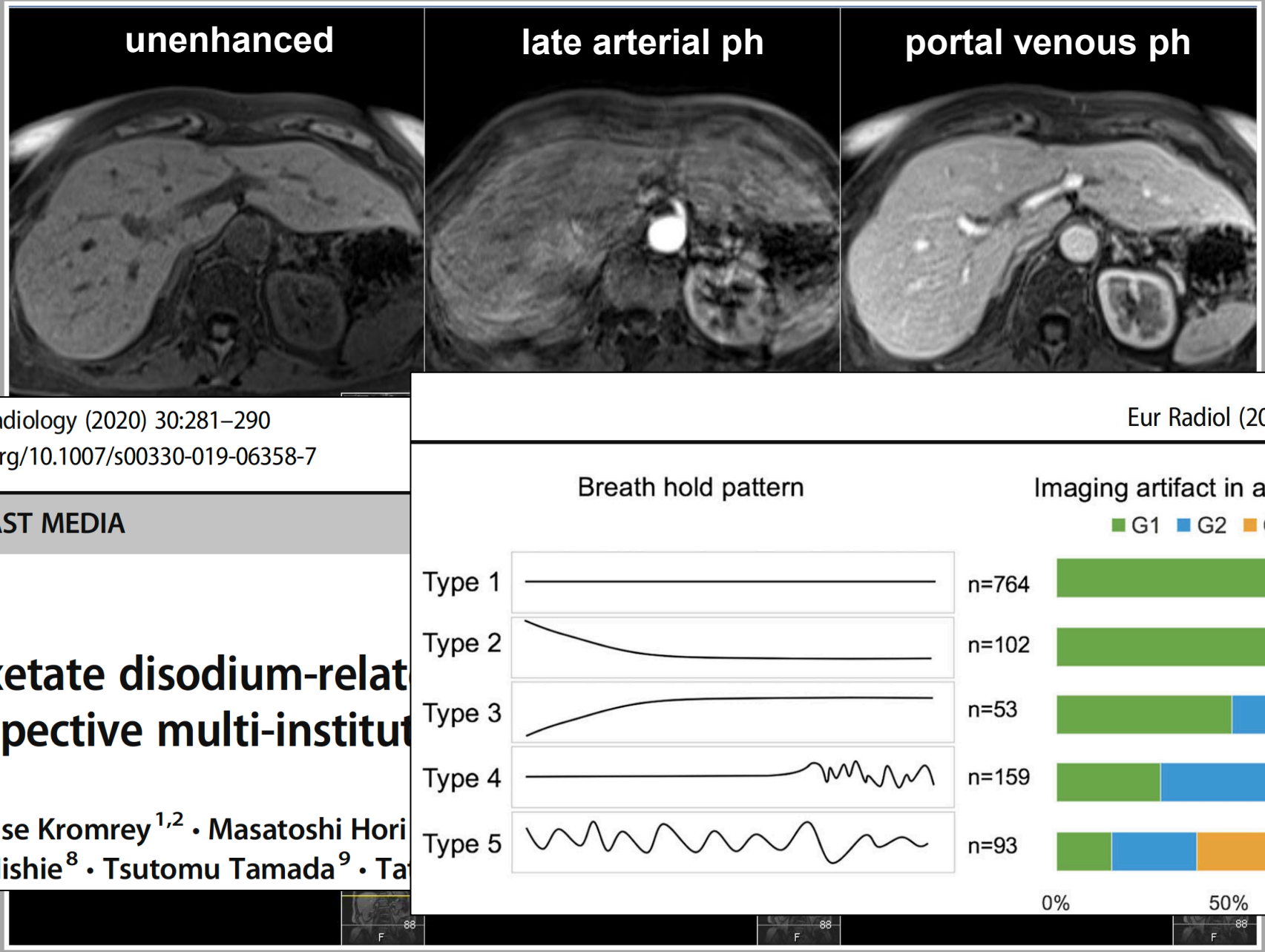
European Radiology (2020) 30:281–290
https://doi.org/10.1007/s00330-019-06358-7

CONTRAST MEDIA

Check for updates

Gadoxetate disodium-related event during image acquisition: a prospective multi-institutional study for better MR practice

Marie-Luise Kromrey[1,2] · Masatoshi Hori[3] · Satoshi Goshima[4] · Kazuto Kozaka[5] · Tomoko Hyodo[6] · Yuko Nakamura[7] · Akihiro Nishie[8] · Tsutomu Tamada[9] · Tatsuya Shimizu[1] · Akihiko Kanki[9] · Utaroh Motosugi[1]



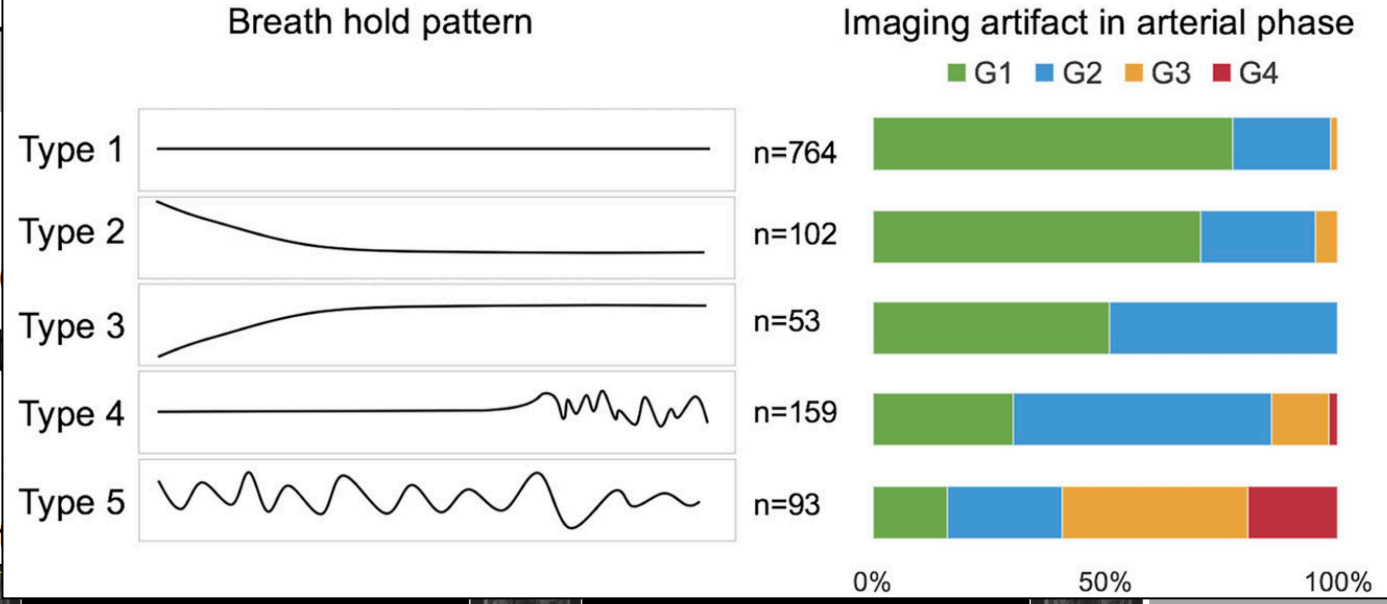
European Radiology (2020) 30:281–290
https://doi.org/10.1007/s00330-019-06358-7

CONTRAST MEDIA

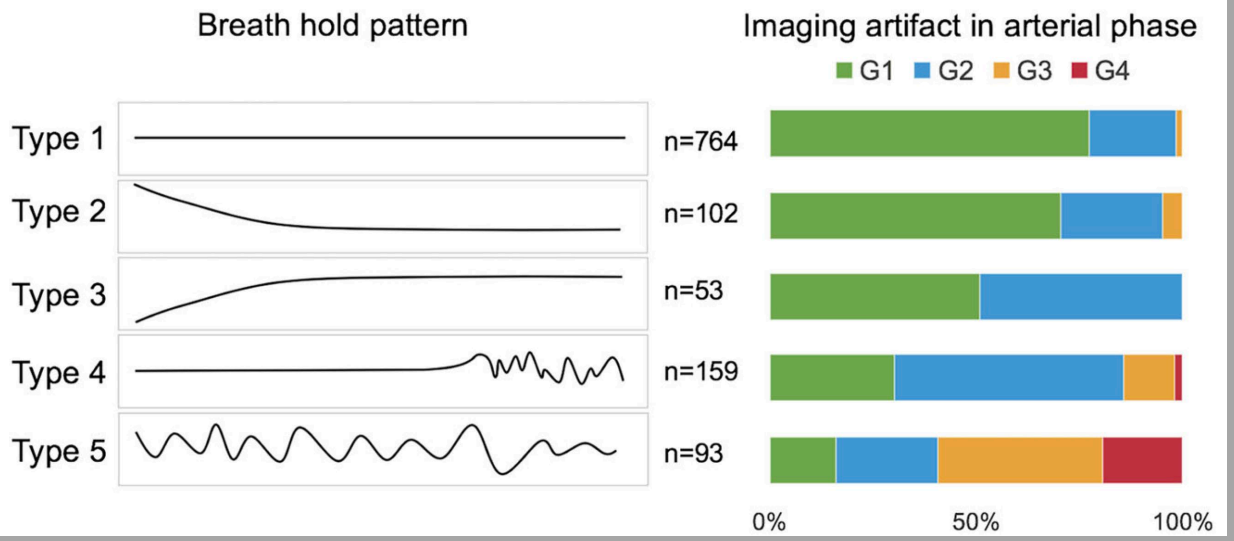
Gadoxetate disodium-relat
a prospective multi-institut

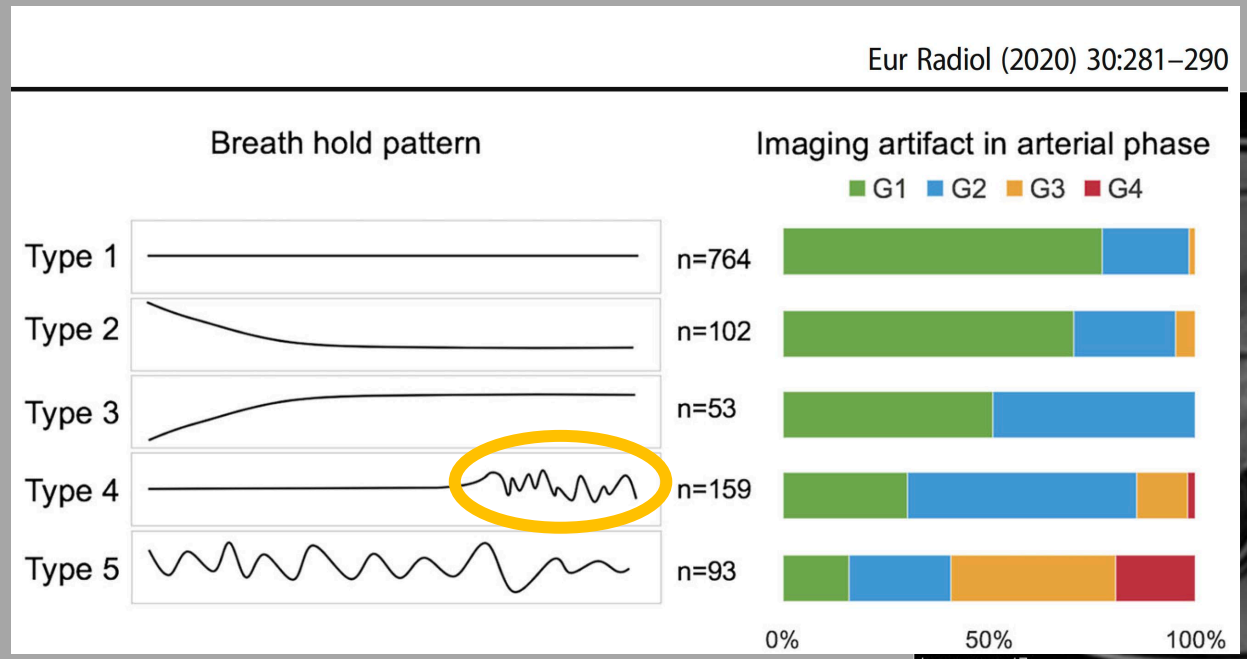
Marie-Luise Kromrey[1,2] · Masatoshi Hori
Akihiro Nishie[8] · Tsutomu Tamada[9] · Ta

Eur Radiol (2020) 30:281–290

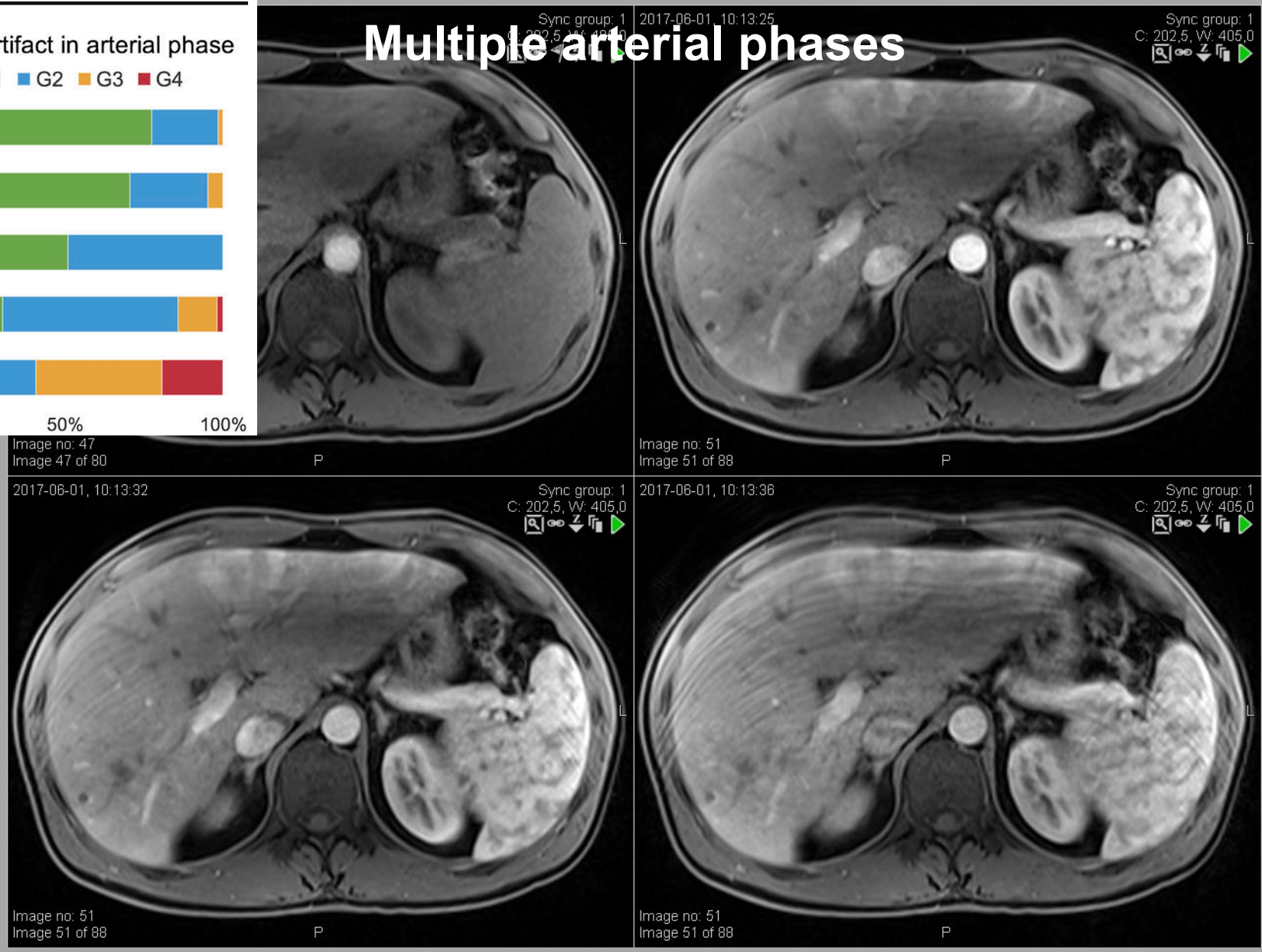


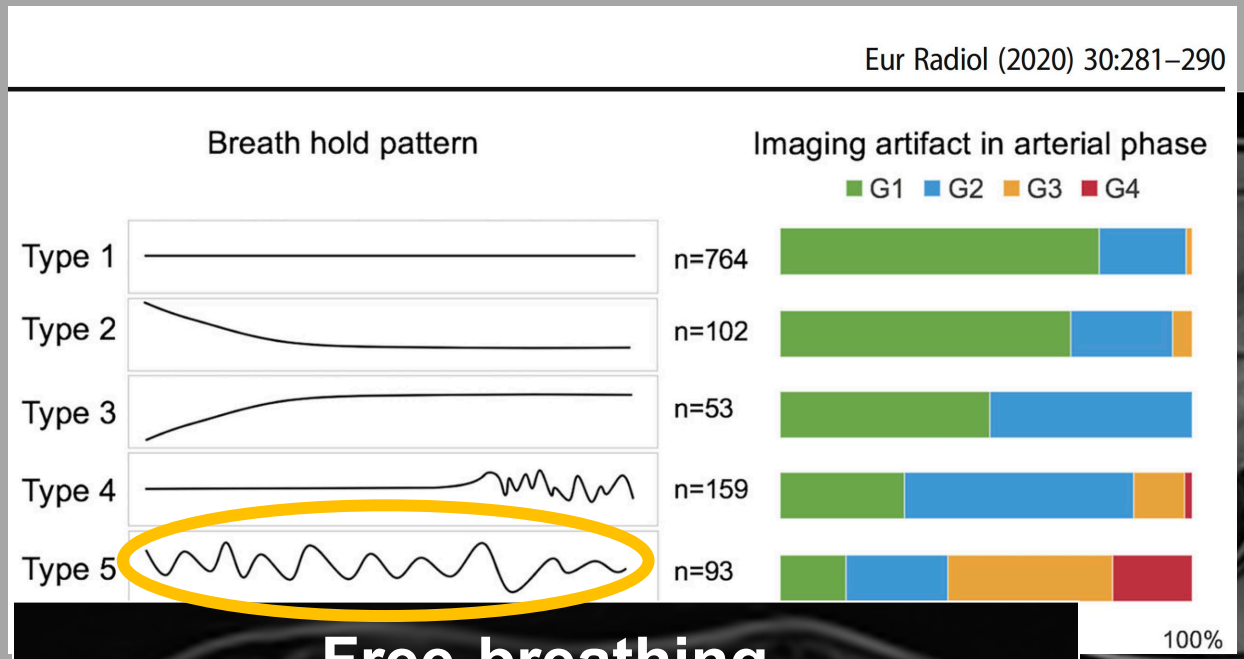
Eur Radiol (2020) 30:281–290



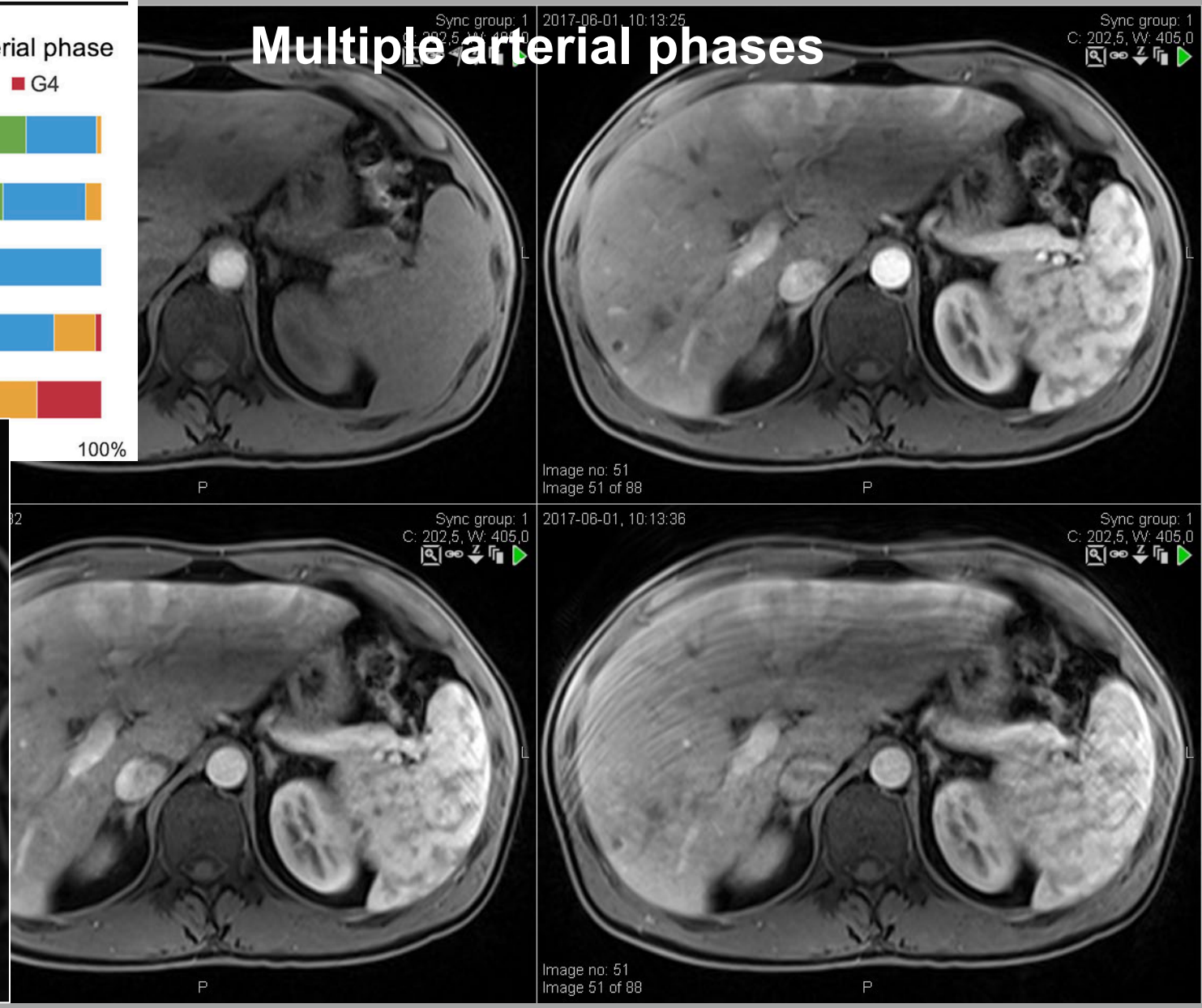


Multiple arterial phases

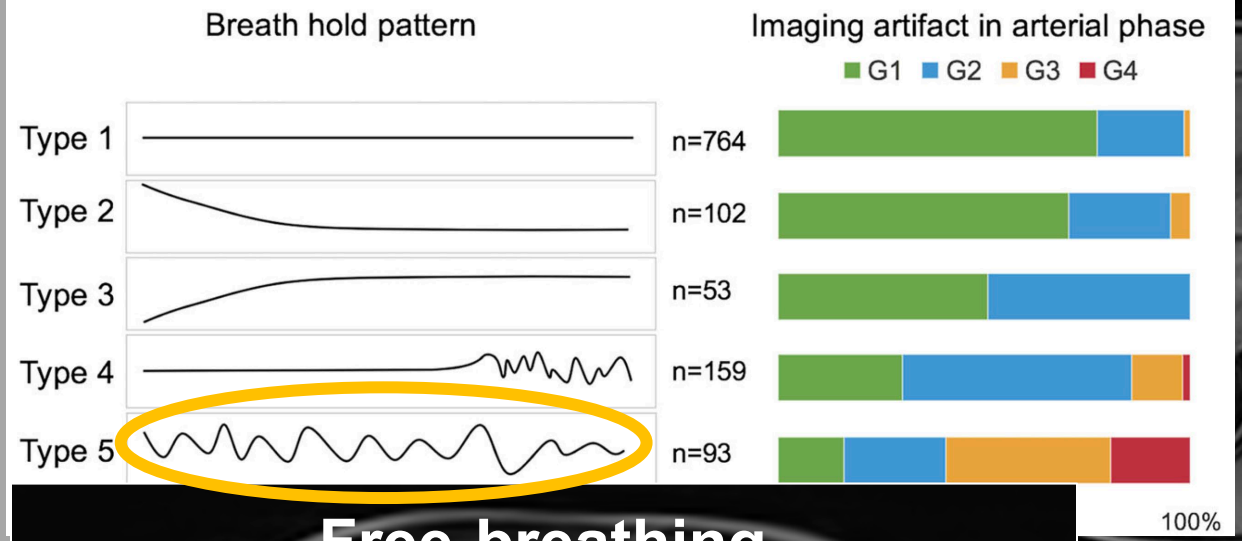


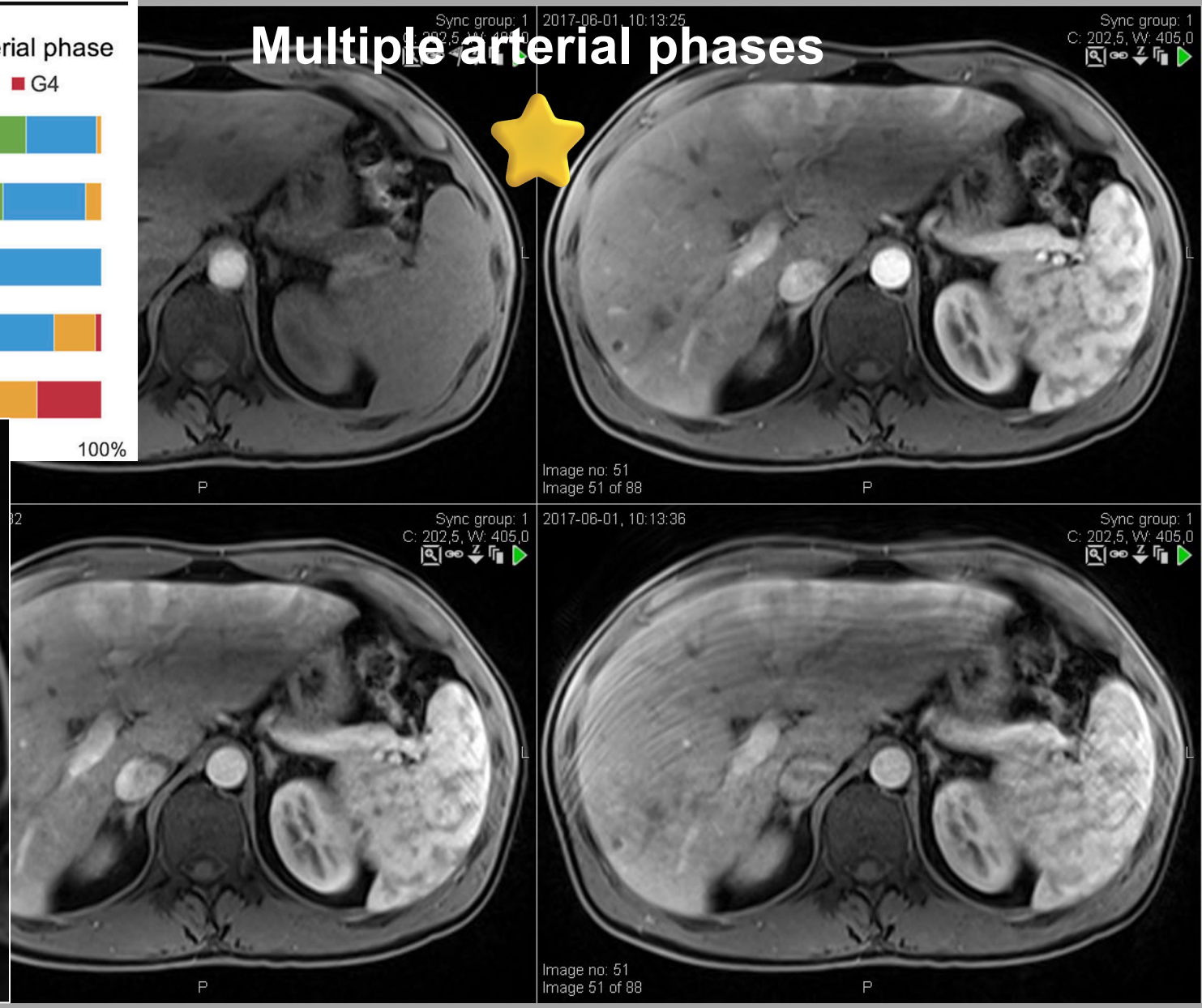

Eur Radiol (2020) 30:281–290
Breath hold pattern
Imaging artifact in arterial phase
G1 G2 G3 G4
Type 1
Type 2
Type 3
Type 4
Type 5
n=764
n=102
n=53
n=159
n=93
100%


Free-breathing


Multiple arterial phases
Sync group: 1
2017-06-01, 10:13:25
C: 202,5, W: 405,0
Image no: 51
Image 51 of 88
P
2017-06-01, 10:13:36

Eur Radiol (2020) 30:281–290





Technique LS-CA

	• Gadobenate dimeglumine Gd-BOPTA **MultiHance**	• Gadoxetic acid Gd-EOB-DTPA **Primovist**
Excretion:	– 5% hepatobiliary & 95% renal	– 50% hepatobiliary & 50% renal
½ life:	– 1-2 h	– 1 h
Recom. dose @ inj. rate:	– 0.05 mmol Gd/kg (=0.1 ml/kg) @ 2 ml/s	– 0.025 mmol Gd/kg (=0.1 ml/kg) @ 2 ml/s

Technique LS-CA

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Technique LS-CA

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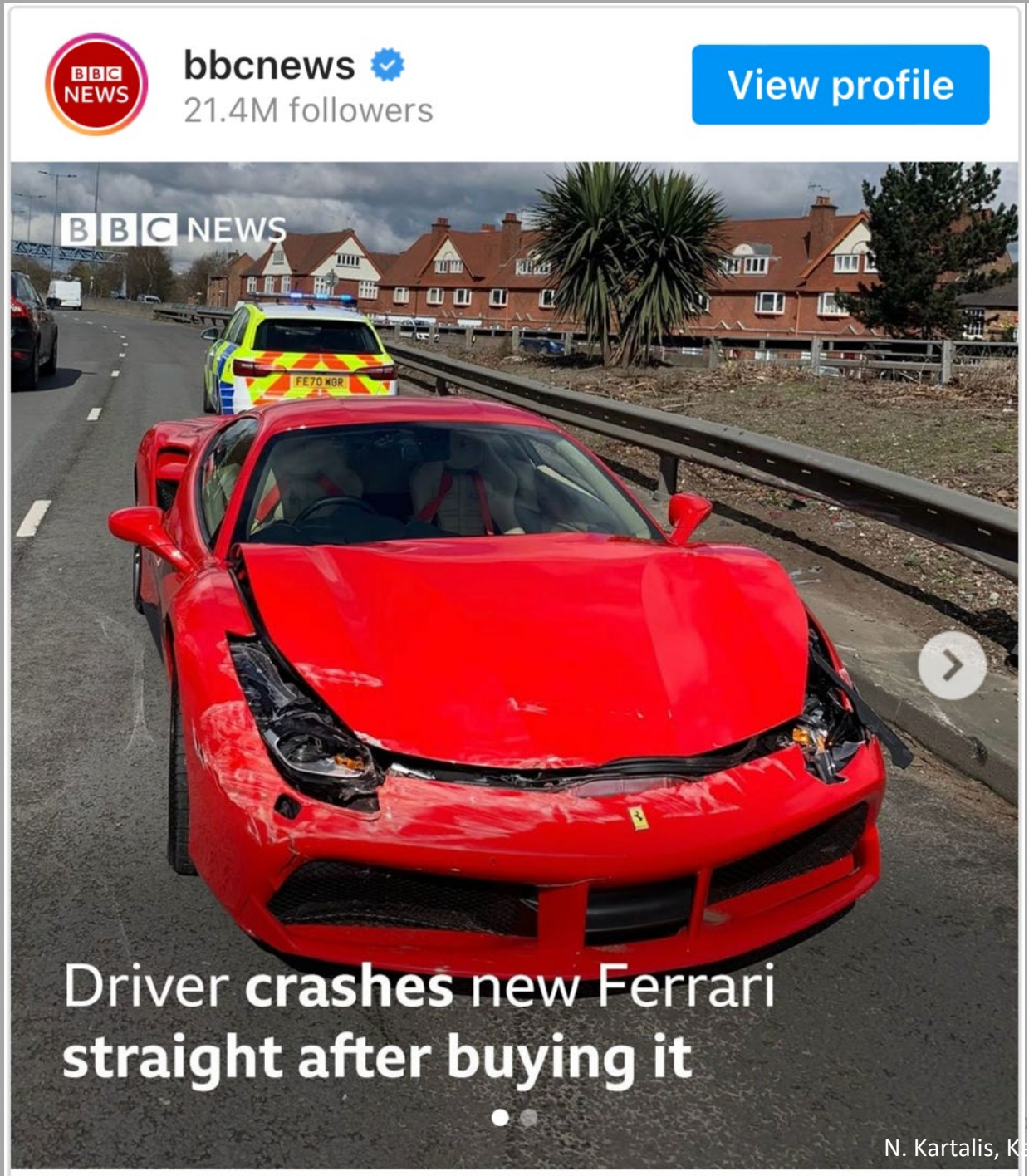
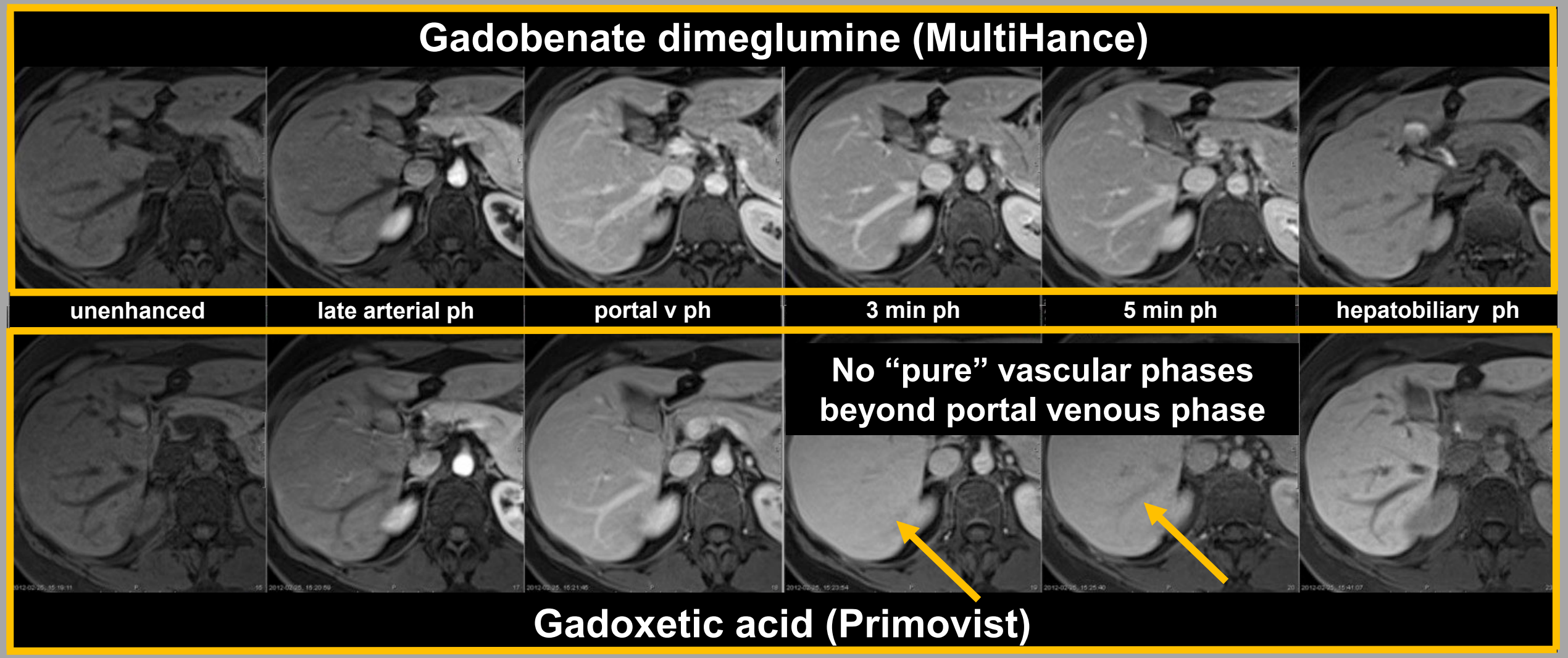
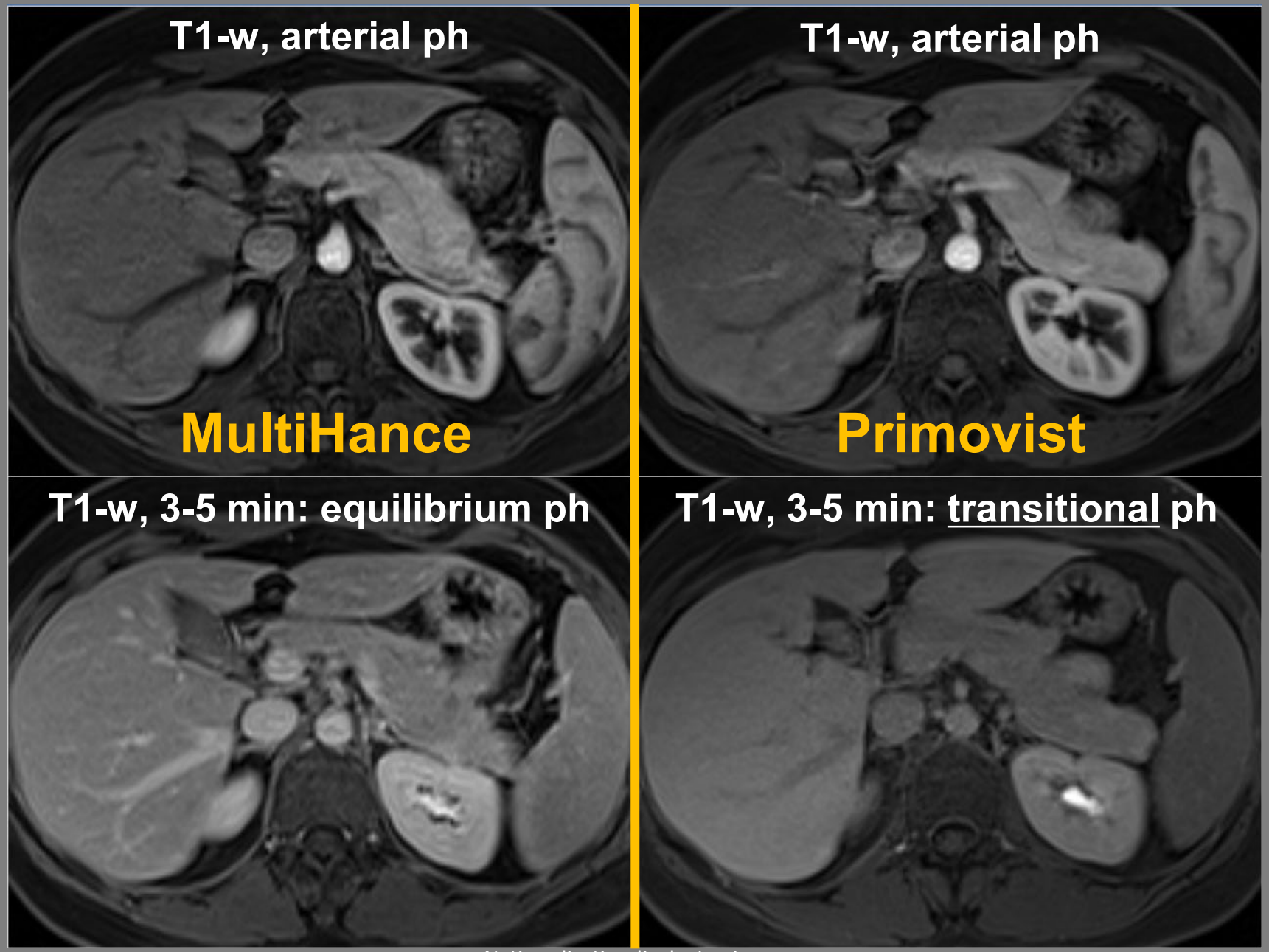


Outline

- Lecture
  - Mechanism of action
  - Added value in characterization
  - ***Pitfalls and limitations 4***
- Case-based interactive discussion
  - Take-home

Liver-specific contrast agents (MRI)





!!!

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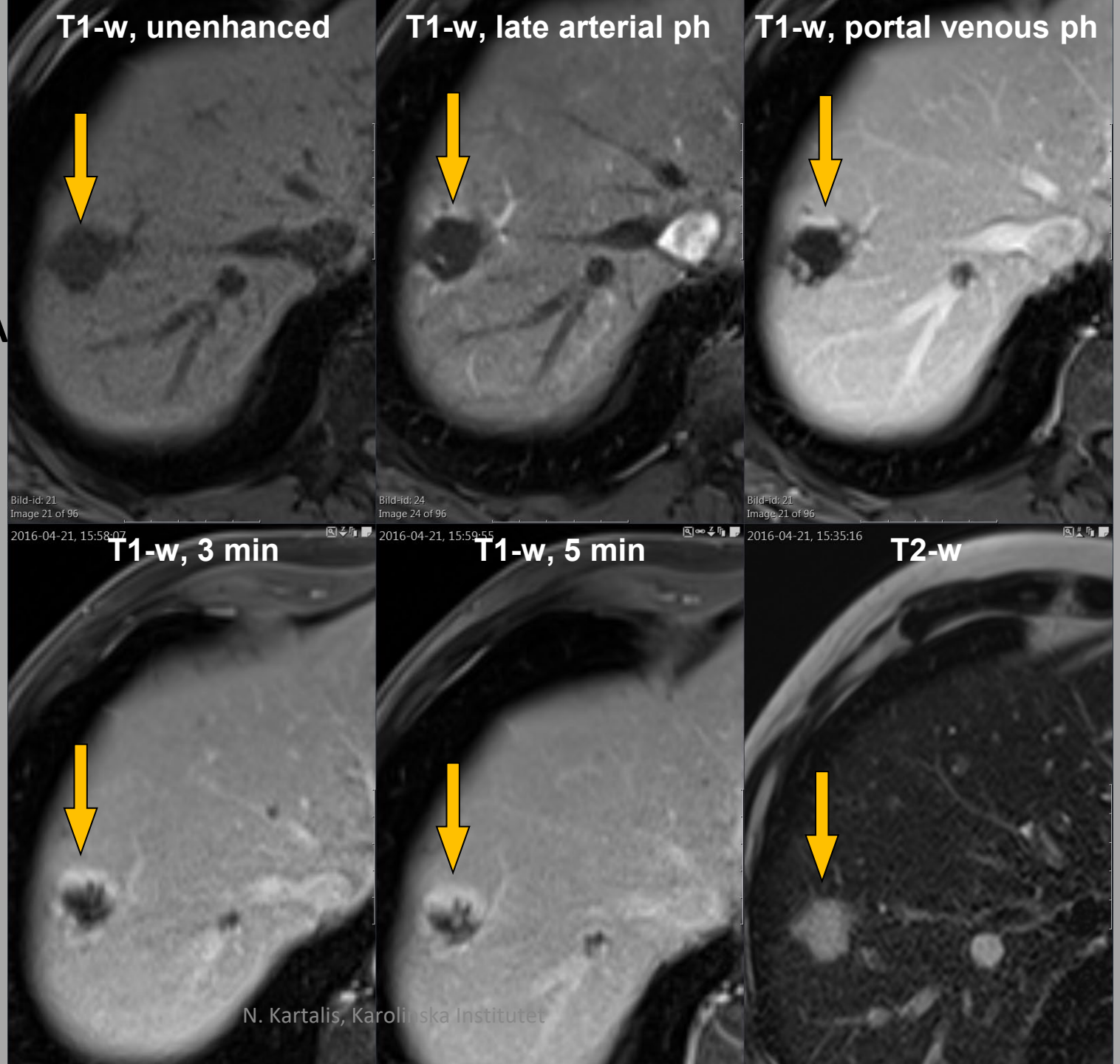
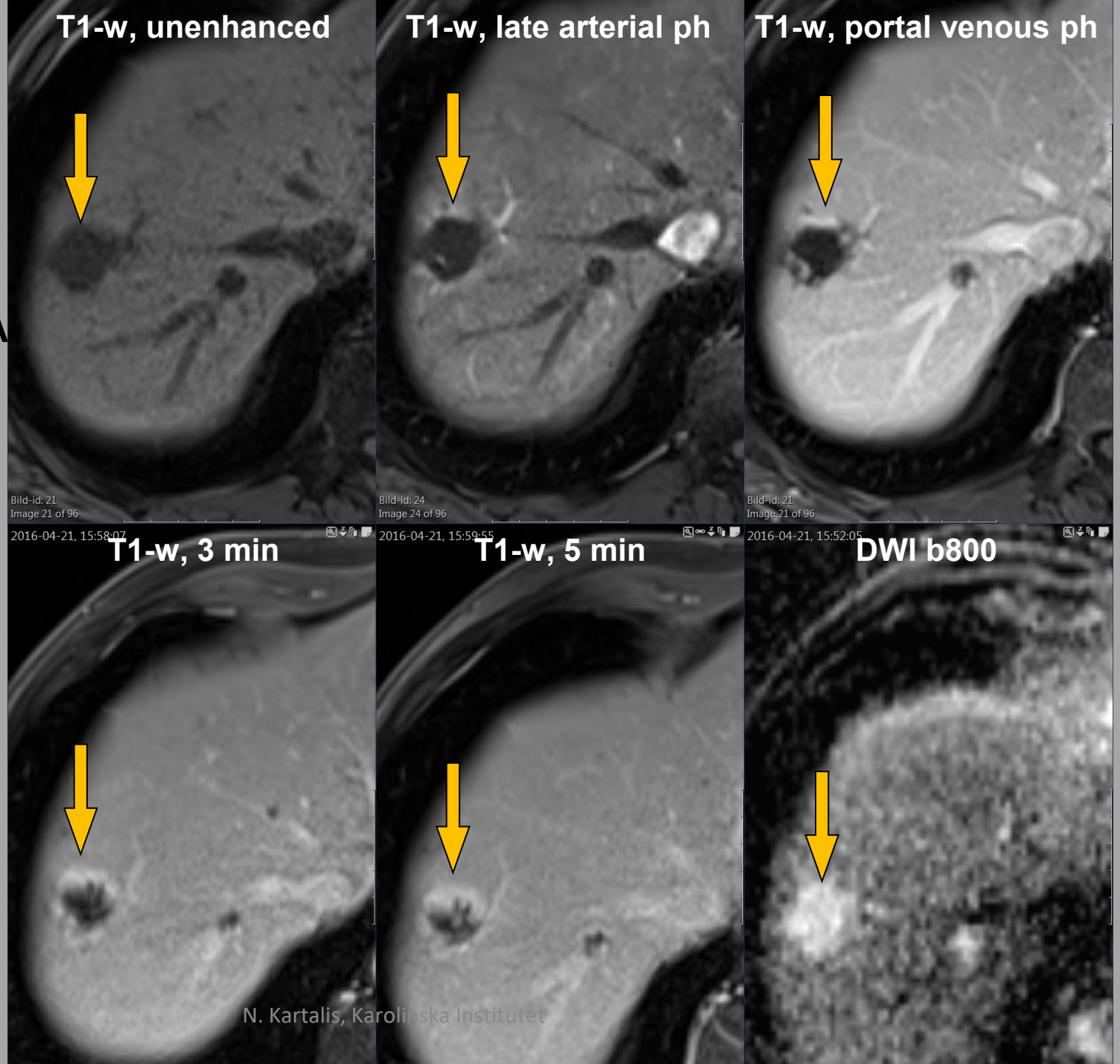
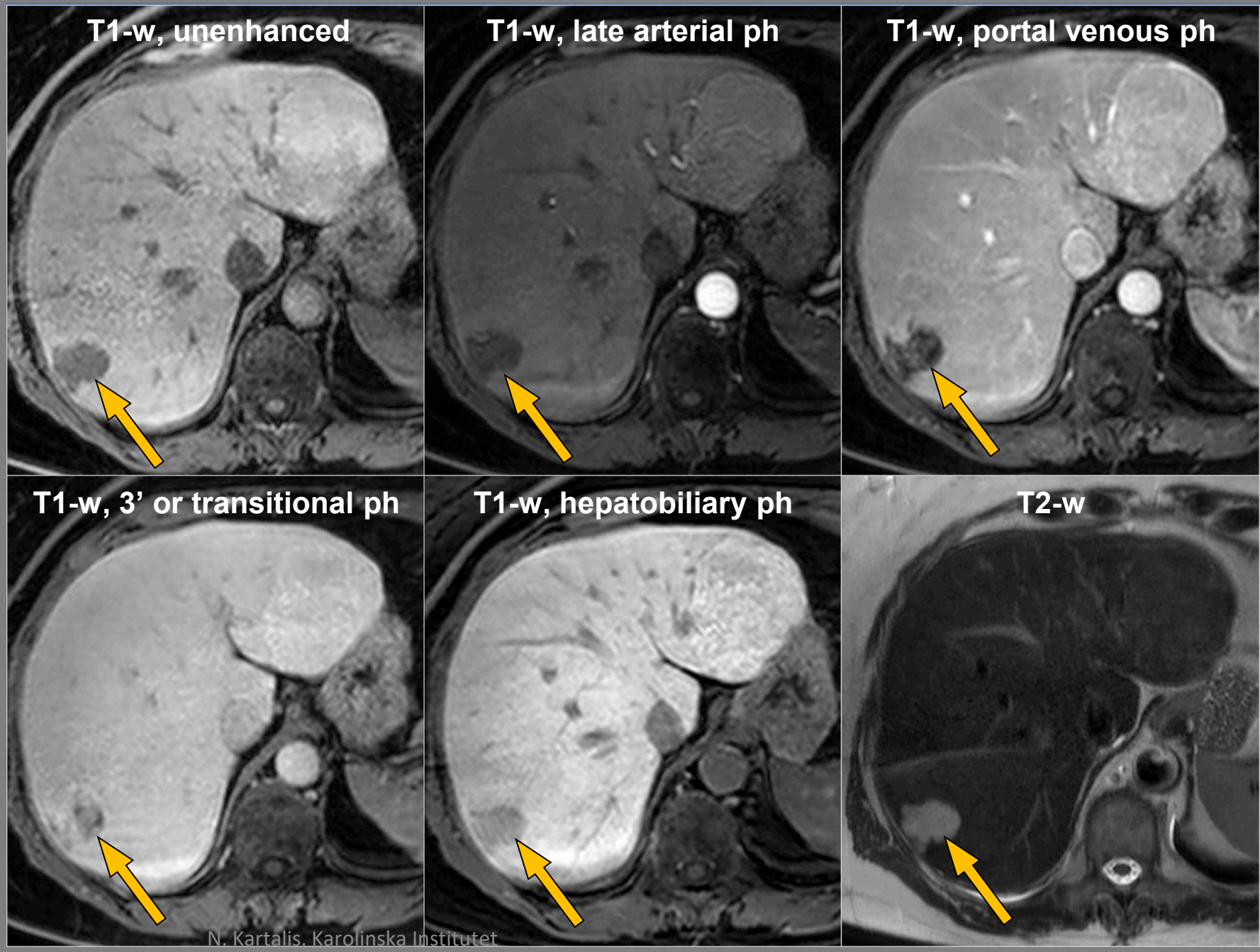
- Hemangioma EC-CA
  - ➢ Typical CE-pattern



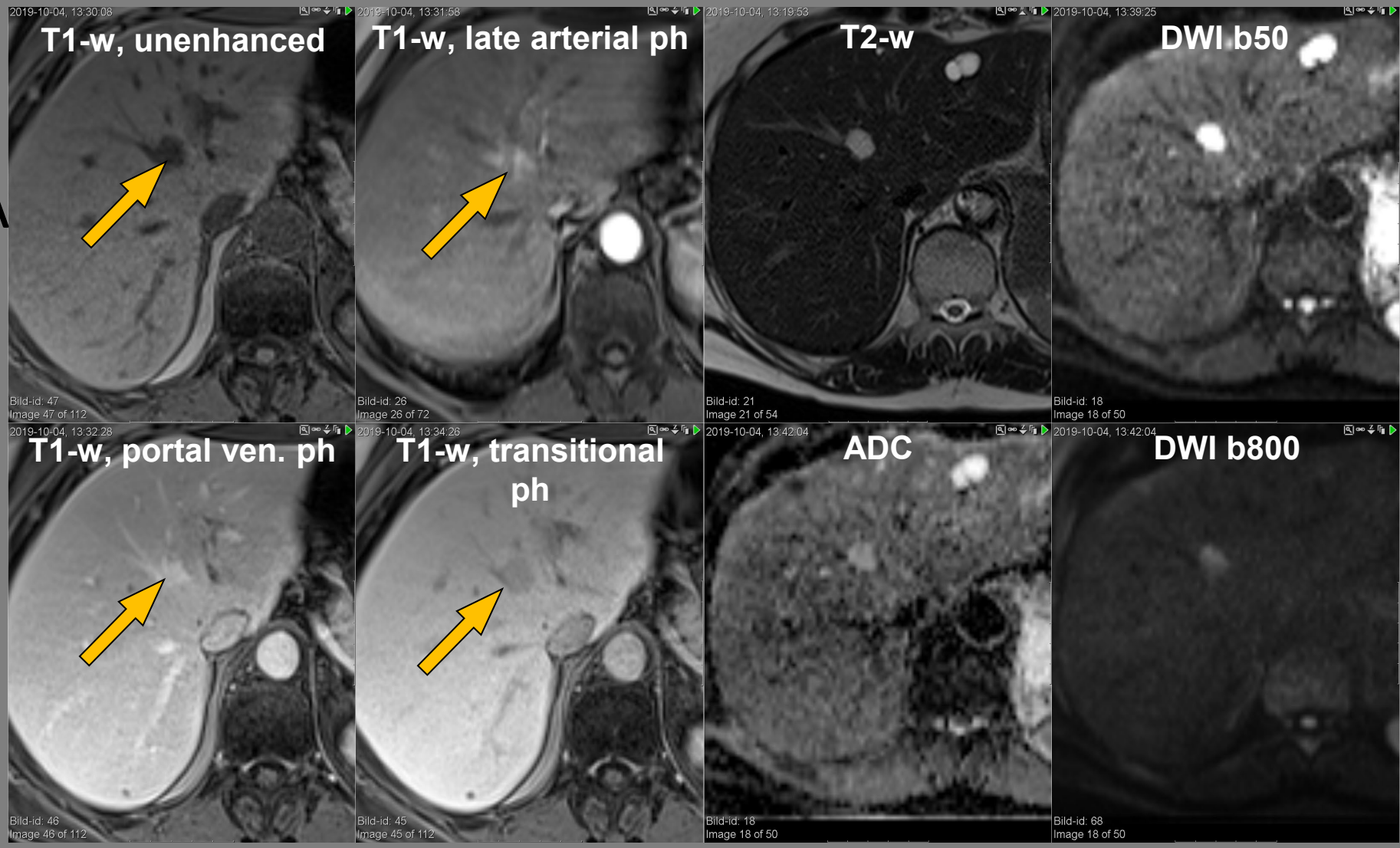
- Hemangioma EC-CA
  - ➢ Typical CE-pattern



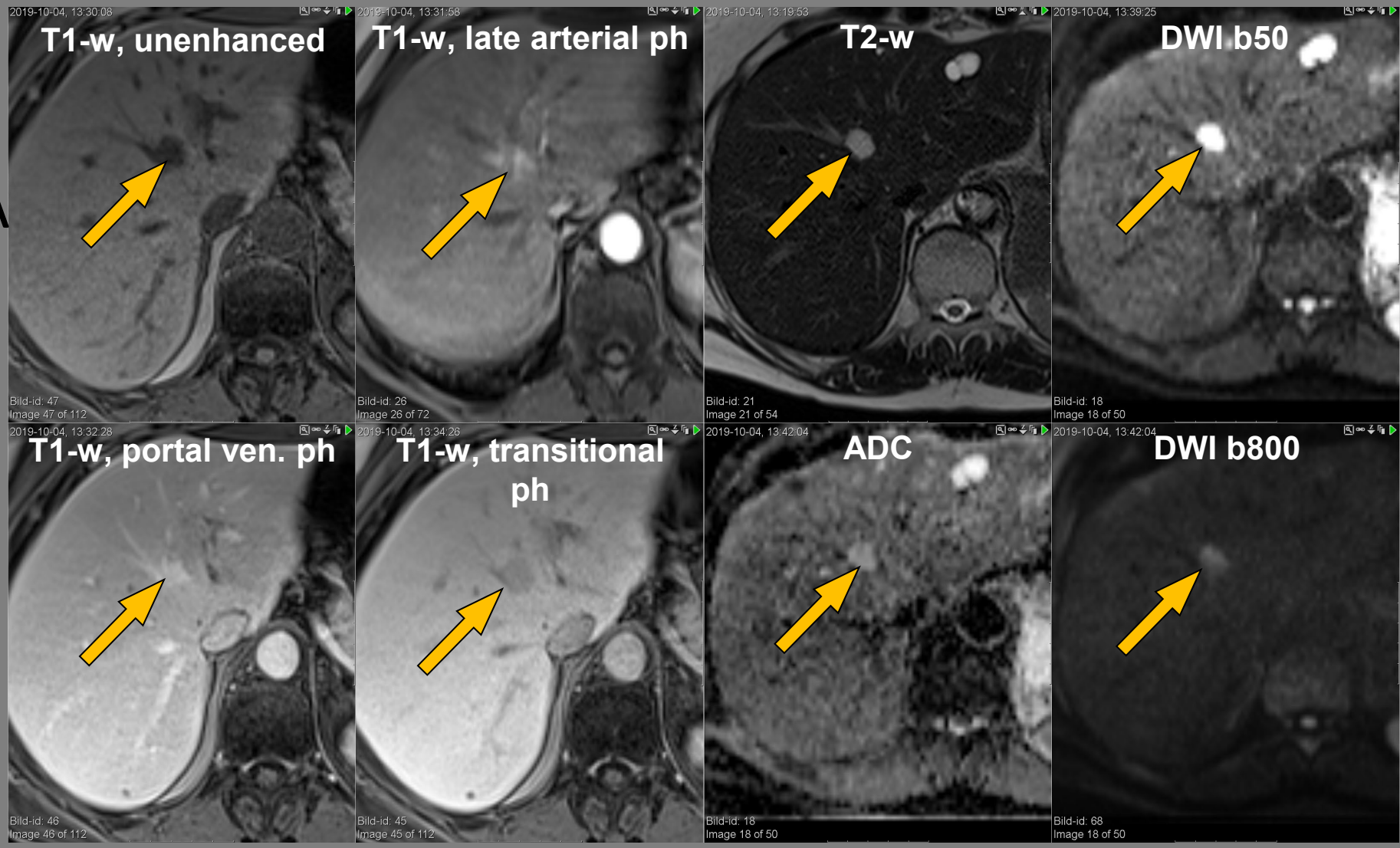
- Hemangioma LS-CA
  - ➢ Typical CE-pattern



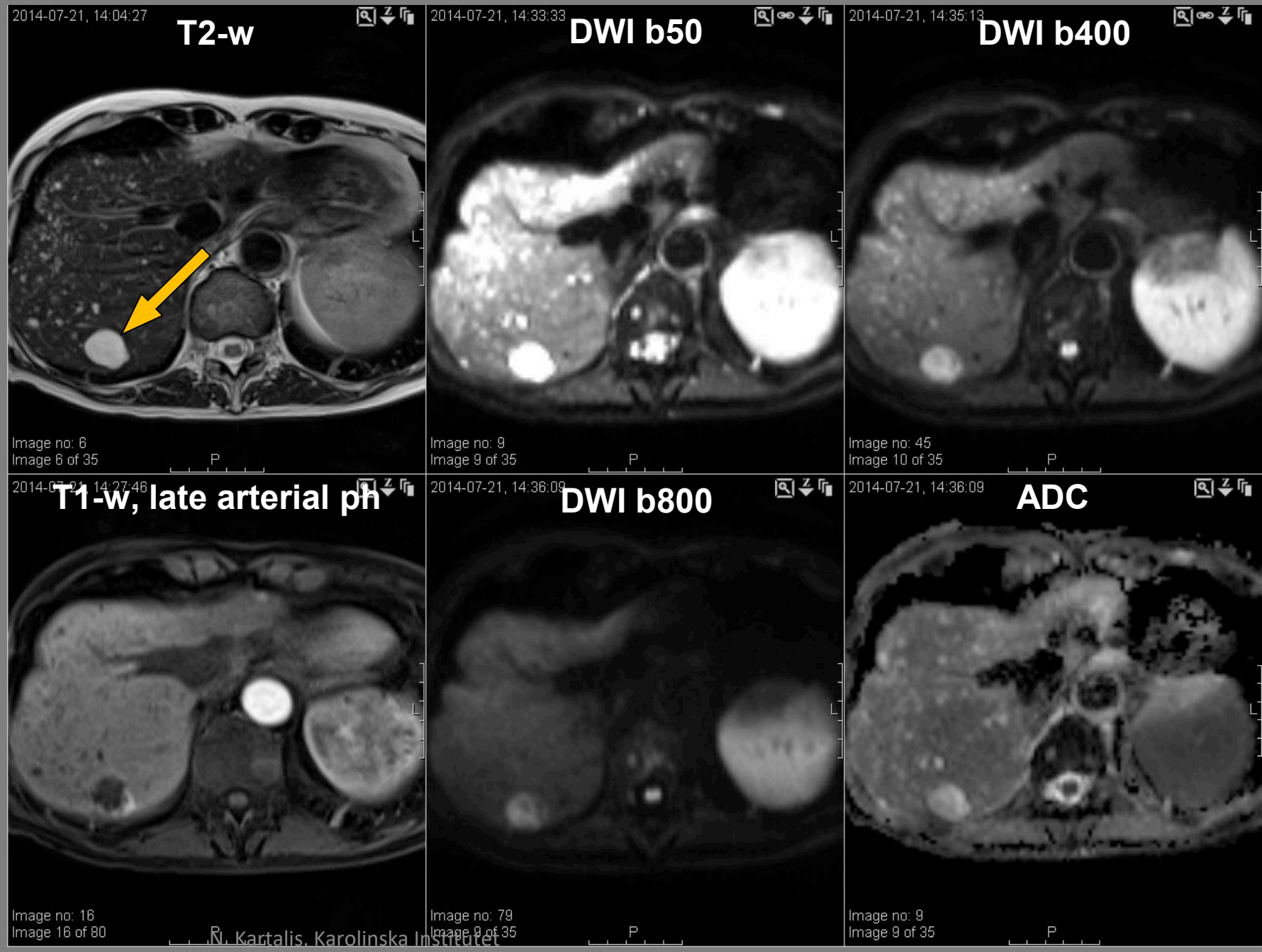
- Hemangioma LS-CA
  - ➢ “Flash-filling”: pseudo-washout



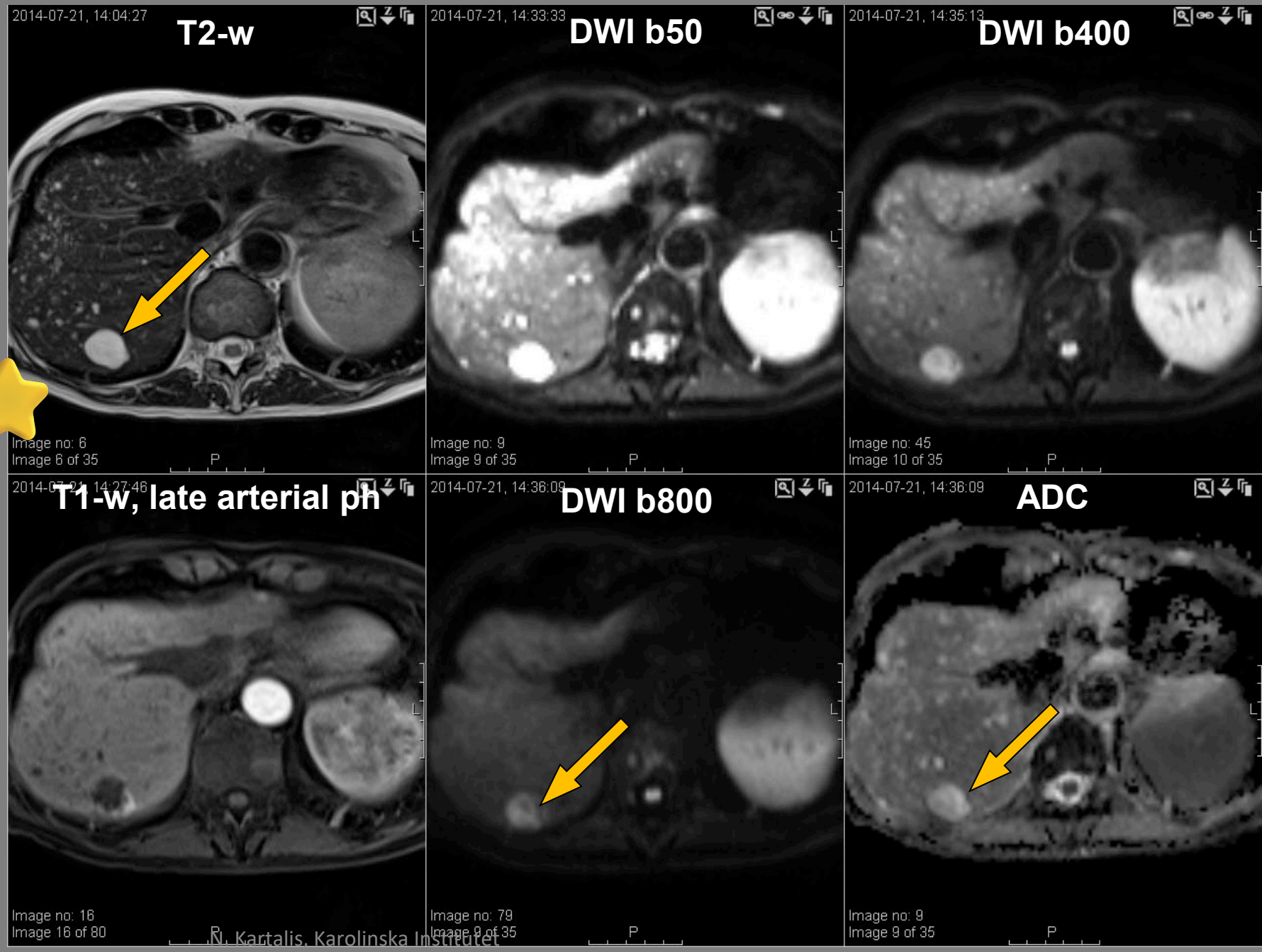
- Hemangioma LS-CA
  - ➢ “Flash-filling”: pseudo-washout



- Hemangioma
  - ➢ High SI T2-w

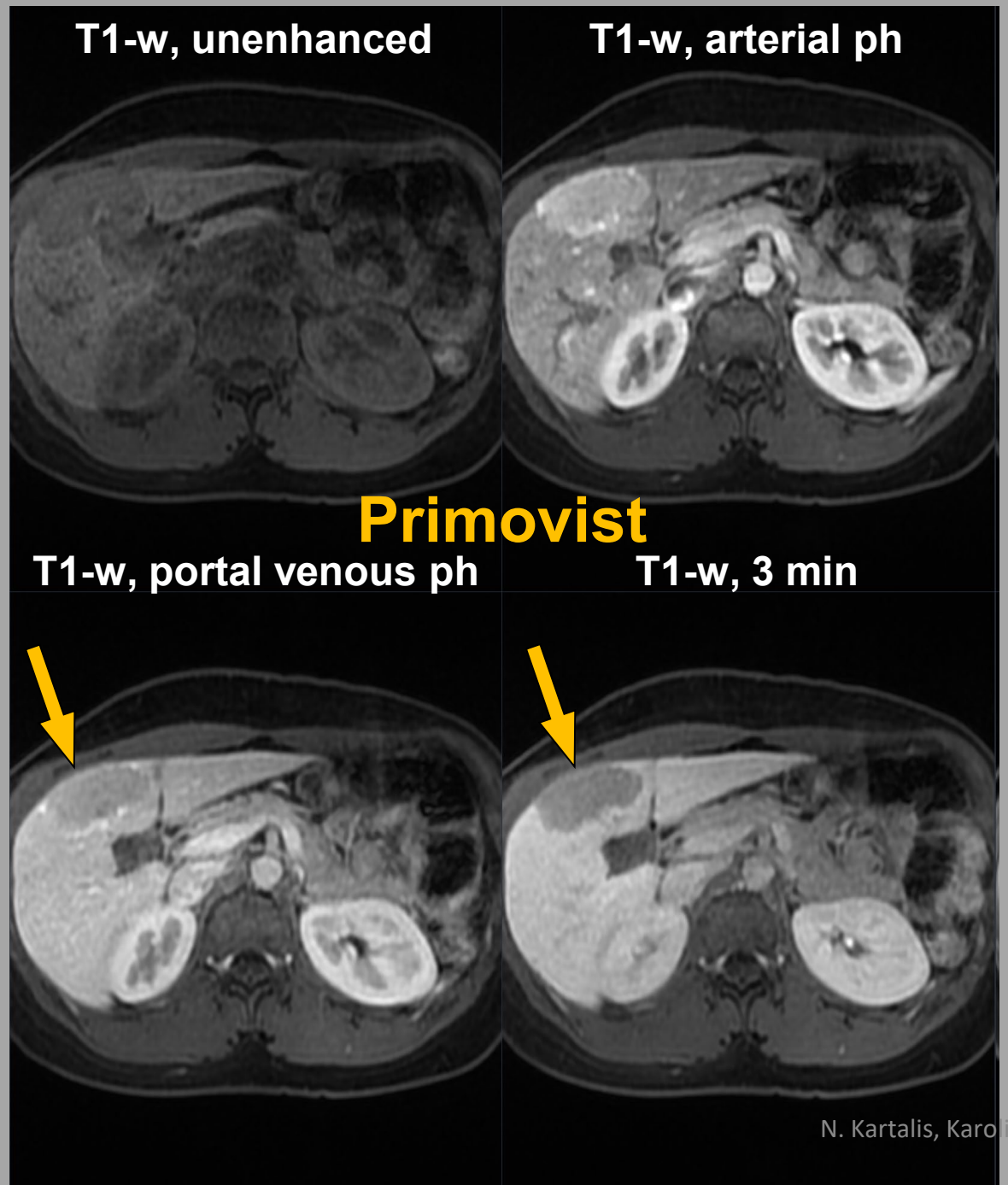


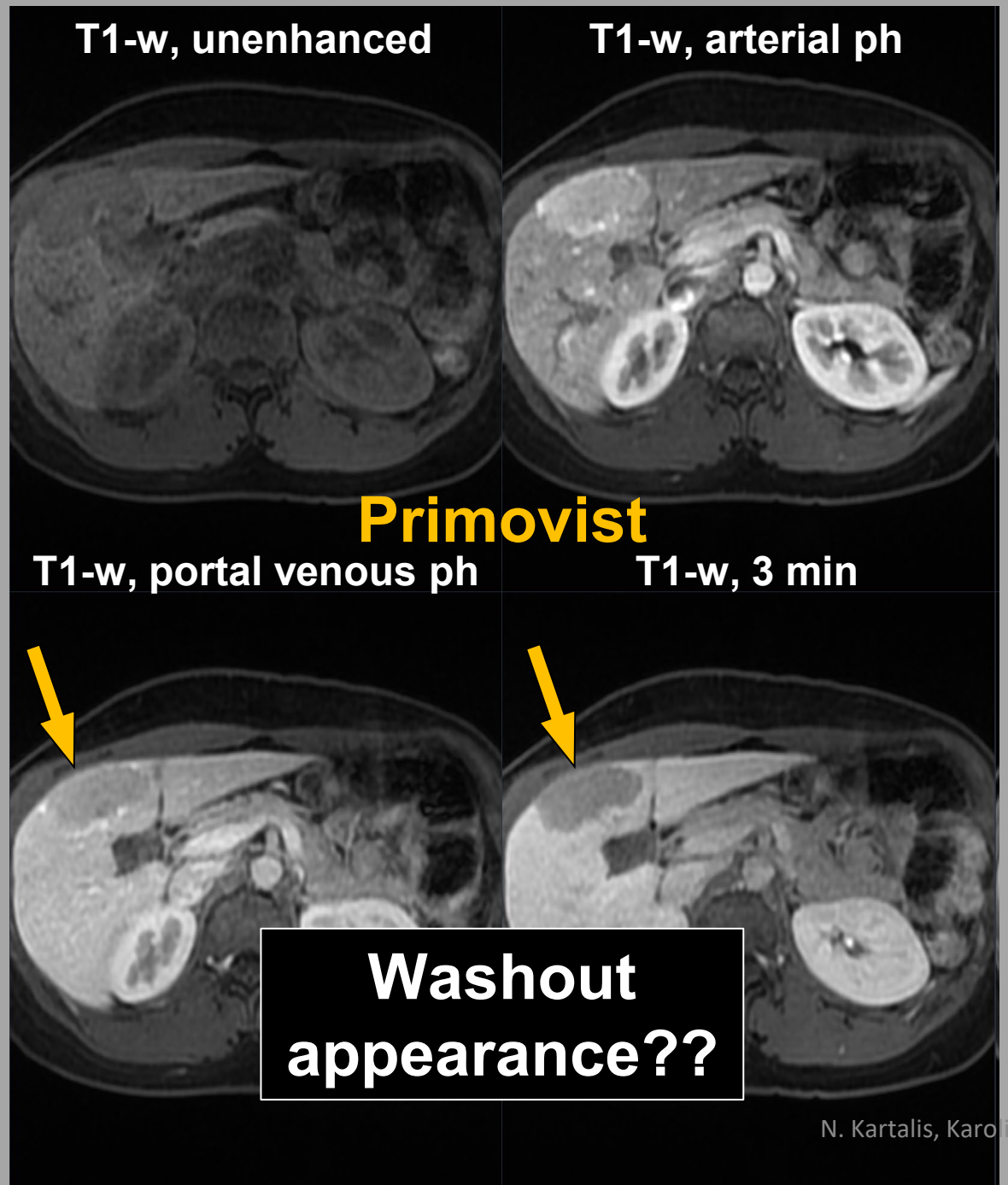
- Hemangioma
  - ➢ High SI T2-w
  - ➢ No impeded diffusion

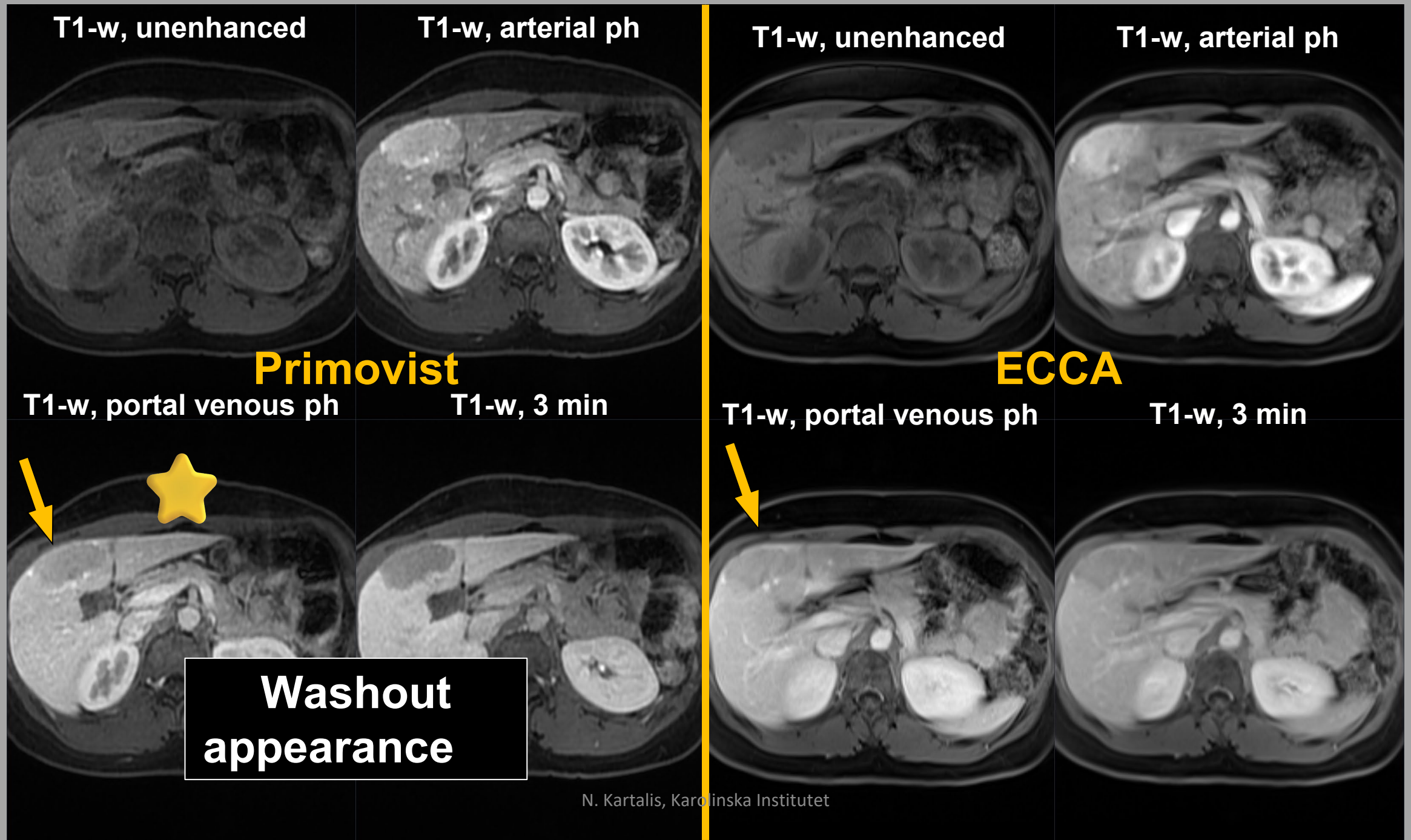


Outline

- Lecture
  - Mechanism of action
  - Added value in characterization
  - ***Pitfalls and limitations 5***
- Case-based interactive discussion
  - Take-home


T1-w, unenhanced
T1-w, arterial ph
Primovist
T1-w, portal venous ph
T1-w, 3 min


T1-w, unenhanced
T1-w, arterial ph
Primovist
T1-w, portal venous ph
T1-w, 3 min
Washout appearance??



EASL diagnostic algorithm and recall policy

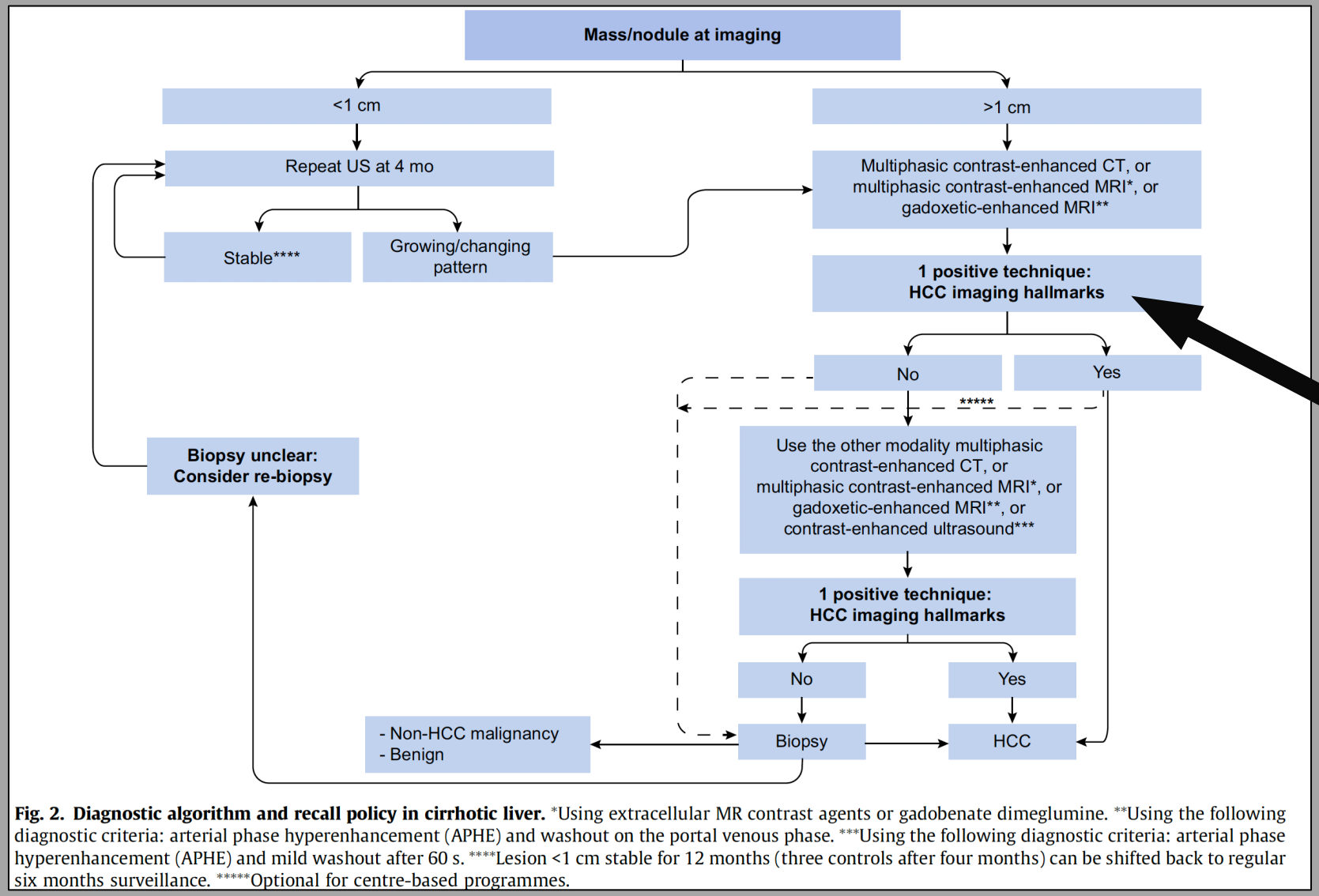


Fig. 2. Diagnostic algorithm and recall policy in cirrhotic liver. *Using extracellular MR contrast agents or gadobenate dimeglumine. **Using the following diagnostic criteria: arterial phase hyperenhancement (APHE) and washout on the portal venous phase. ***Using the following diagnostic criteria: arterial phase hyperenhancement (APHE) and mild washout after 60 s. ****Lesion <1 cm stable for 12 months (three controls after four months) can be shifted back to regular six months surveillance. *****Optional for centre-based programmes.

Arterial hypervascularity (APHE)
&
venous/late phase washout

EASL-EORTC clinical practice guidelines: management of hepatocellular carcinoma. J Hepatol. 2018.

CT/MRI Diagnostic Table

Arterial phase hyperenhancement (APHE)		No APHE		Nonrim APHE		
Observation size (mm)		< 20	≥ 20	< 10	10-19	≥ 20
Count additional major features: • Enhancing "capsule" • Nonperipheral "washout" • Threshold growth	None	LR-3	LR-3	LR-3	LR-3	LR-4
	One	LR-3	LR-4	LR-4	LR-4 / LR-5	LR-5
	≥ Two	LR-4	LR-4	LR-4	LR-5	LR-5

LR-4 / LR-5

Observations in this cell are categorized based on one additional major feature:

- LR-4 – if enhancing "capsule"
- LR-5 – if nonperipheral "washout" **OR** threshold growth

Outline

- Lecture
  - Mechanism of action
  - Added value in characterization
  - Pitfalls and limitations
- ***Case-based interactive discussion***
  - Take-home

Many thanks!

nikolaos.kartalis@ki.se