



MRI of peritoneal diseases

Vincent Vandecaveye,
Department of Radiology, University Hospitals
Leuven, Leuven/BE

Peritoneal tumour: primitive versus secondary

Secondary peritoneal tumours much more frequent than primary

CLASSIFICATION OF TUMORS AND TUMORLIKE LESIONS OF THE PERITONEUM

PRIMARY TUMORS OF THE PERITONEUM

Mesothelioma
Primary peritoneal serous carcinoma

Malignant: epitheloid - sarcomatoid
Uncertain malignant potential

SECONDARY TUMORS OF THE PERITONEUM

Ovarian cancer
Gastrointestinal cancer
Pseudomyxoma Peritonei
Sarcomas
Lymphoma

Malignant

OTHER PERITONEAL TUMORS OF UNCERTAIN ORIGIN

Desmoplastic small round cell tumor
Leiomyomatosis peritonealis disseminata

Malignant – high mortality rate

Benign but metastatic –
very low causative mortality rate

MISCELLANEOUS ENTITIES THAT MIMIC PERITONEAL MALIGNANCY

Granulomatous peritonitis
Foreign body granuloma
Inflammatory pseudotumor / Inflammatory myofibroblastic tumor
Endometriosis
Splenositis

Benign
Rare presentation as sarcoma

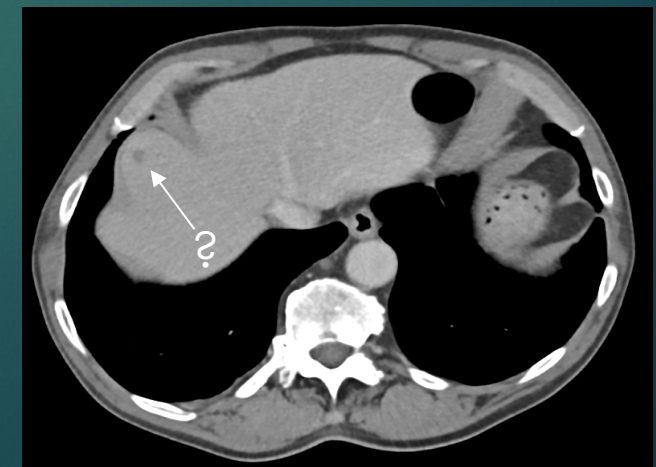
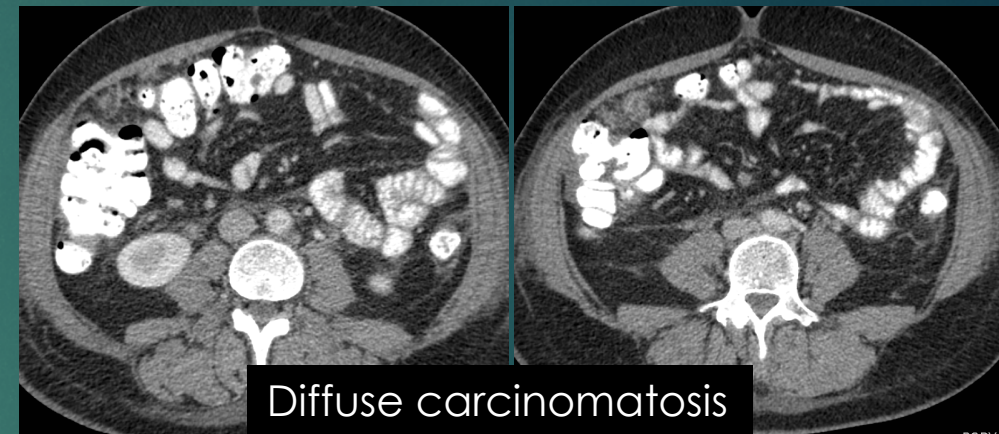
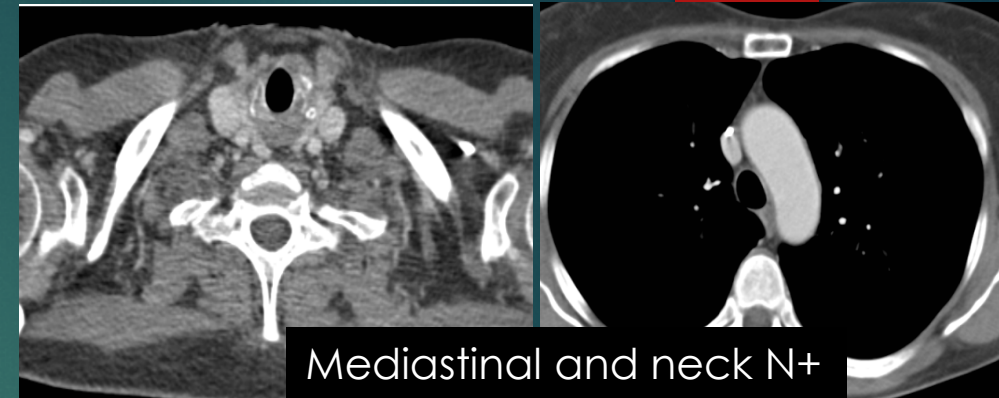
Computed Tomography: Difficult to predict peritoneal resectability or lymph node involvement

Insufficient accuracy to predict (in)complete resection

Table 3
External validation of three prediction models.

	Sensitivity	Specificity	PPV	NPV	Pre-test probability	Post-test probability
1. Ferrandina model A: cut-off > 5/8						
Ferrandina et al.	22.9	97.7	92.6	50.0	55.8	92.6
Reader 1	23.2	88.0	68.4	50.6	53.6	68.4
Reader 2	34.0	84.3	69.2	55.1	53.6	69.2
Reader 3	31.3	86.1	75.0	48.4	53.6	75.0
2. Ferrandina model B: cut-off > 3/5						
Ferrandina et al.	23.9	97.7	92.8	50.3	55.8	92.8
Reader 1	18.2	92.0	71.4	50.5	53.6	71.4
Reader 2	32.3	88.5	76.9	52.3	53.6	76.9
Reader 3	31.3	85.7	75.0	47.6	53.6	75.0

Rutten IJ et al, Gynecol Oncol 2016



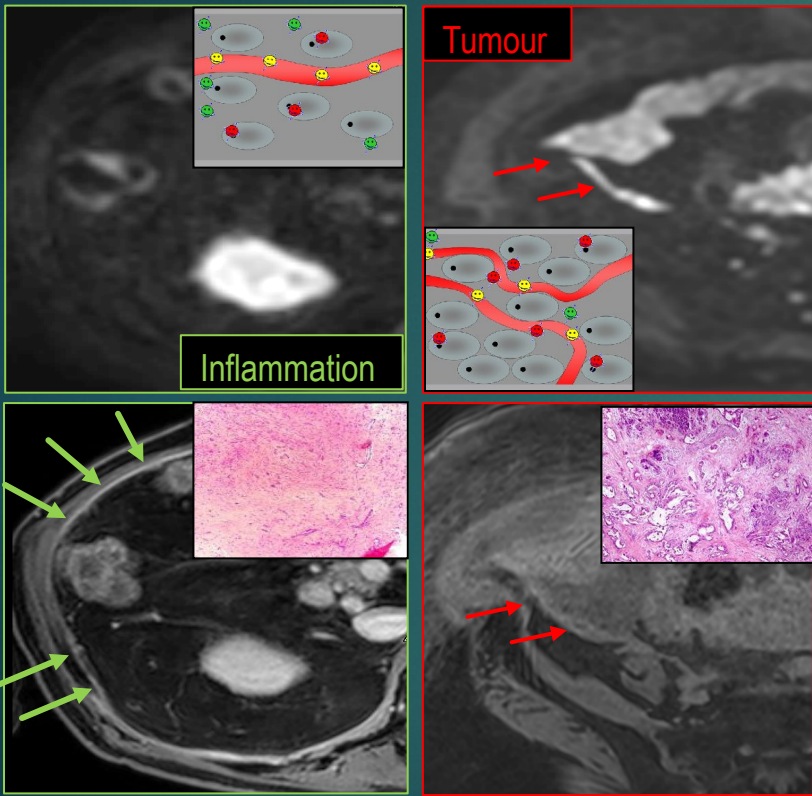
- ** Low specificity for hemangiomas < 1 cm (67%)
- ** Lower sensitivity for liver metastases in case of steatosis (31-38%)
- ** Lymph nodes < 1 cm difficult to stage - **Threshold nodal N+ chest = 0,5 cm!**
- ** Small or less conspicuous peritoneal metastases:
Intestinal serosa: 21-25% sensitivity
Peritoneal metastases < 5 mm: 11% sensitivity

Rationale for (WB-)DWI/MRI

Modality	Sensitivity	Specificity	Diagnostic OR
Region based			
CT	0.68 (0.46–0.84)	0.88 (0.81–0.93)	15.9 (4.38–58.01)
PET(CT)	0.79 (0.092)	0.90 (0.80–0.96)	36.5 (6.7–200.0)
(DW)MRI	0.91 (0.96)	0.85 (0.78–0.91)	63.3 (31.5–127.3)
Patient based			
CT	0.70 (0.53–0.83)	0.94 (0.87–0.97)	33.5 (16.3–69.0)

Data in parentheses are 95% confidence interval, OR odds ratio

van 't Sant I et al, Eur Radiol 2020

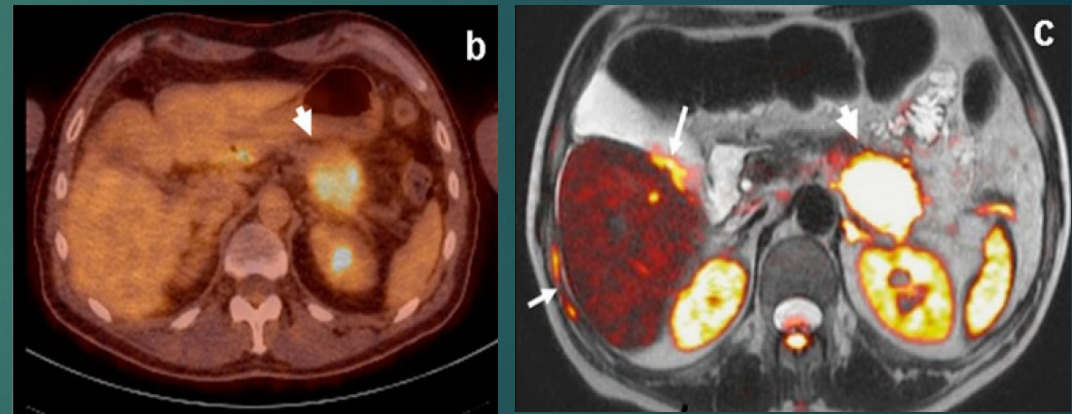


Helsinki museum of art

Table 2 Site-based analysis

Sites	PET/CT				MR-DWI				p
	Se	Sp	PPV	NPV	Se	Sp	PPV	NPV	
Right supramesocolic	60 (3/5)	92 (23/25)	60 (3/5)	92 (23/25)	100 (5/5)	100 (25/25)	100 (5/5)	100 (25/25)	0.48
Left supramesocolic	25 (1/4)	96 (25/26)	50 (1/2)	89 (25/28)	50 (2/4)	100 (26/26)	100 (2/2)	93 (26/28)	1
Inframesocolic	72 (13/18)	75 (9/12)	81 (13/16)	64 (9/14)	72 (13/18)	83 (10/12)	87 (13/15)	67 (10/15)	0.08
Total	63 (17/27)	90 (57/63)	74 (17/23)	85 (57/67)	74 (20/27)	97 (61/63)	91 (20/22)	90 (61/68)	0.27
Interobserver agreement (κ)	0.92 (0.71, 1.12)				0.78 (0.57–0.99)				

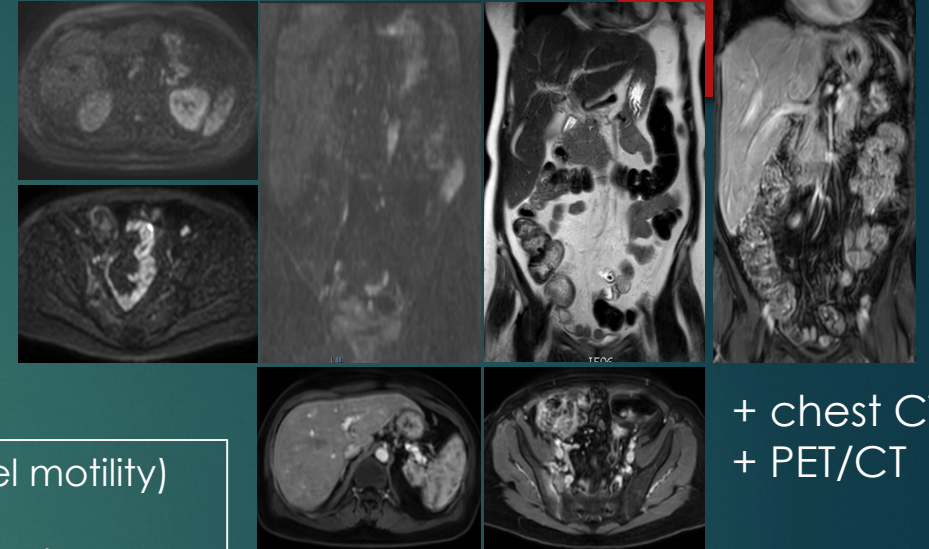
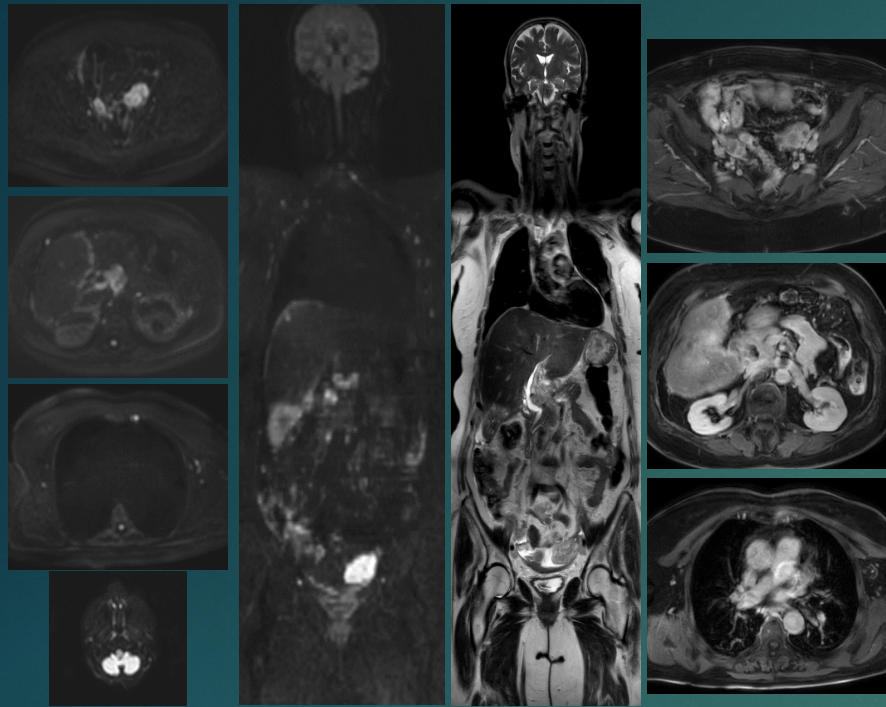
Soussan M Eur Radiol 2012



DWI improves site based lesion detection
 → detection of surgically critical disease site

Not affected by underlying anatomy or metabolism

Short Tau inversion recovery (STIR) DWI/MRI



+ chest CT
+ PET/CT

- * 3 hours fasting (reduces small bowel motility)
- * Negative peroral contrast :
pineapple juice – 7% barium/1 Liter water
- * Antispasmodic

Frequency-based fat-saturation DWI (SPAIR, SPIR,...)

Short Tau Inversion Recovery (STIR) DWI

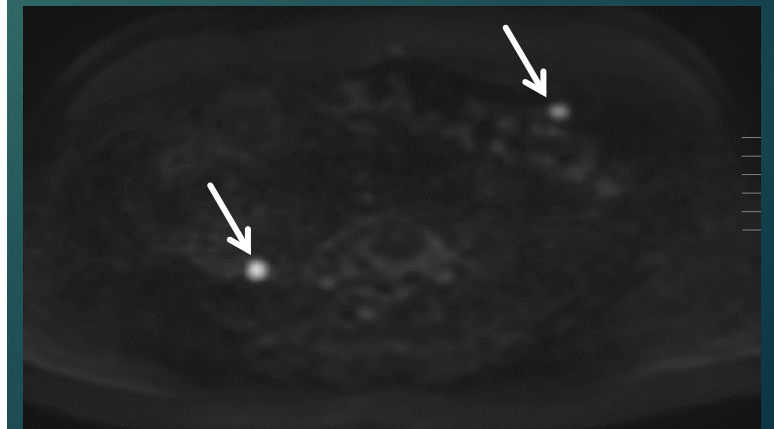
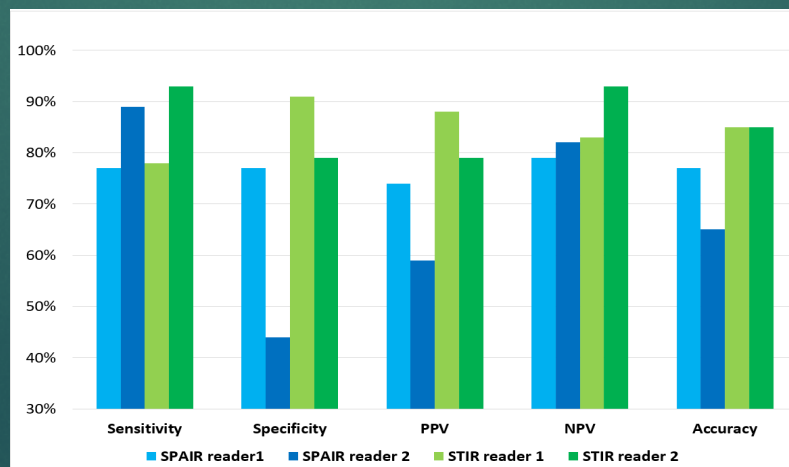
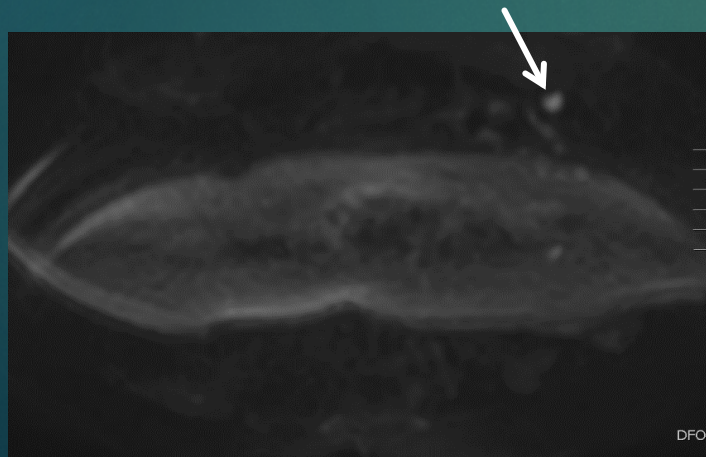
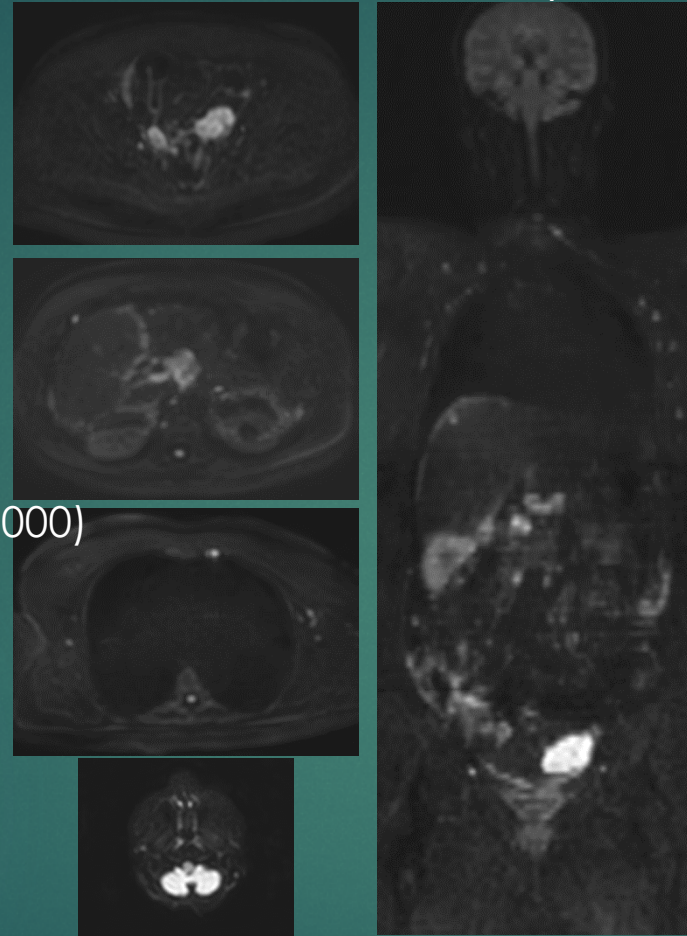


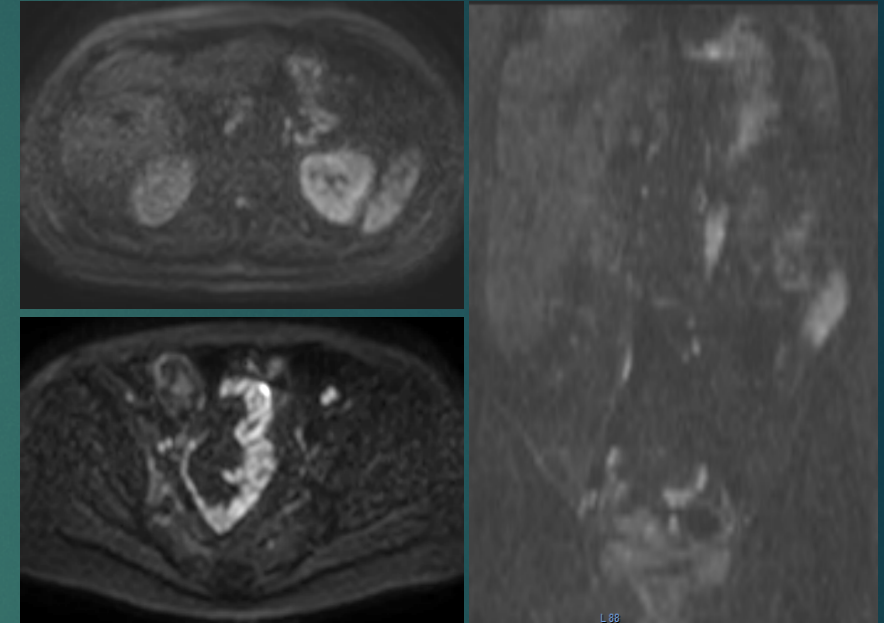
Image interpretation: sequence selection



Whole body



Whole Abdomen (+ chest CT or PET/CT)



- DWI = core sequence
- Detection
- Characterization

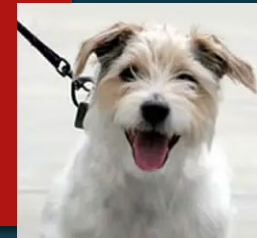
- B-value: 1 low (0-50) and 1 high (b1000)

- ADC minor to no role for staging

→ Qualitative assessment: peritoneal implant = B1000 intensity not attributable to T2 shine-through
• bowel wall signal (pine apple/antispasmodic) or artifact
(STIR)

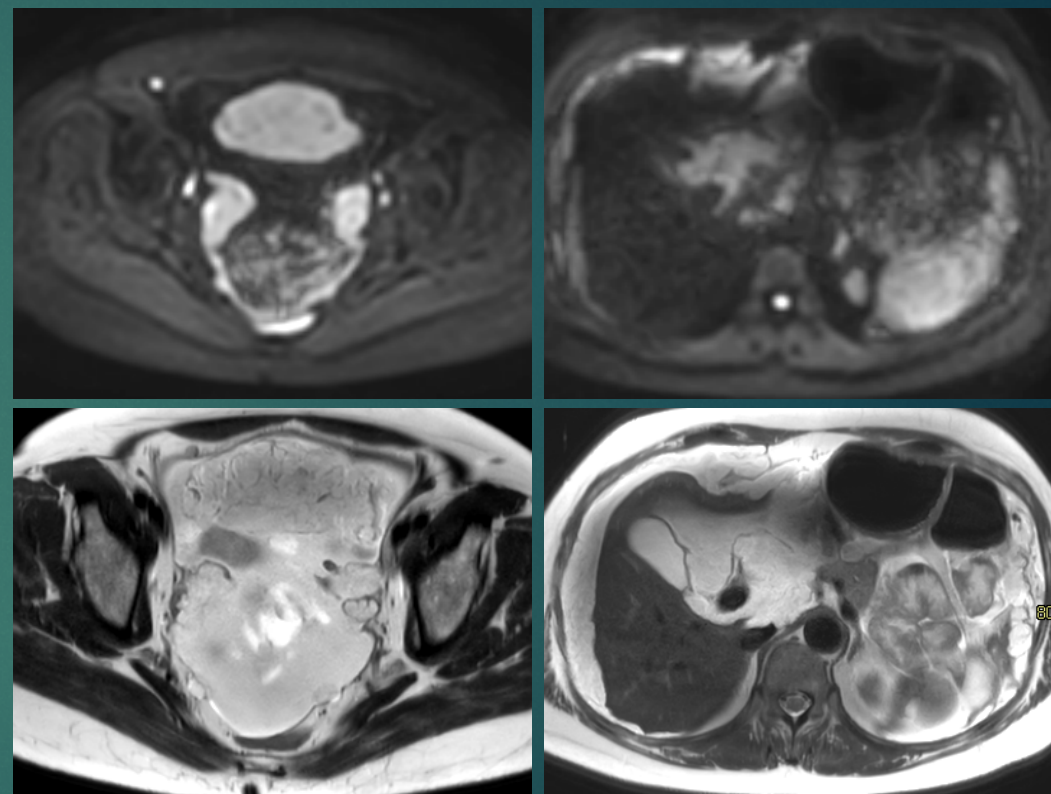
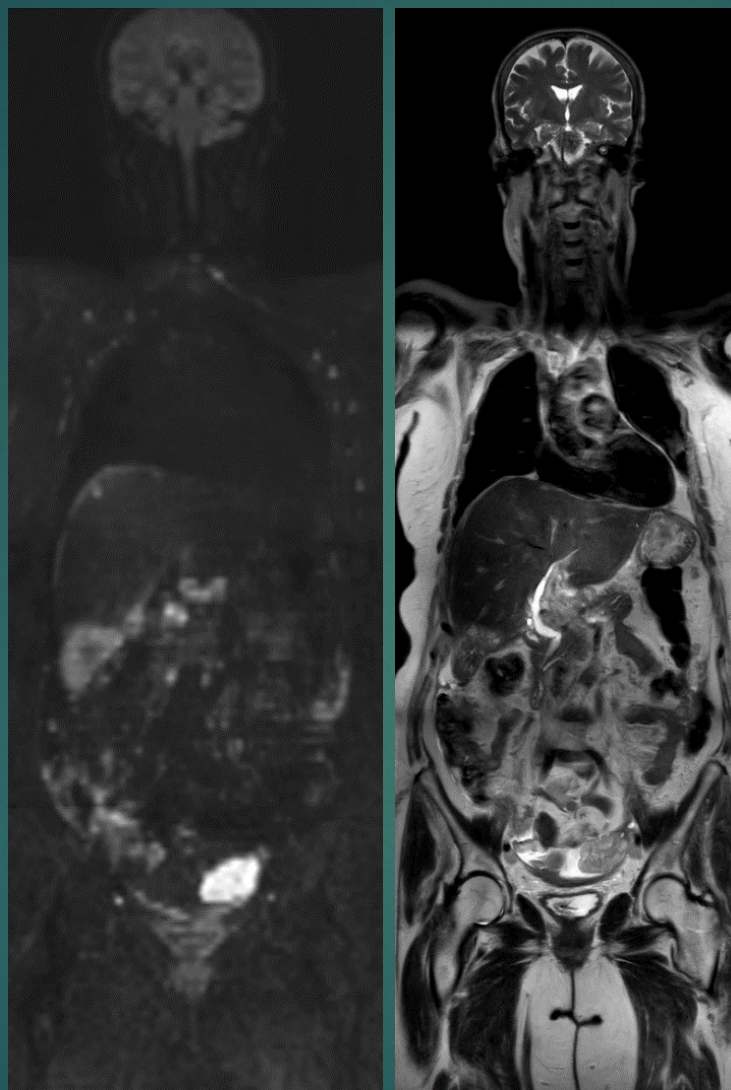
Image interpretation: sequence selection

DWI's best friend



Coronal
T2 single shot
3 stacks (whole body)
48 cm z axis
Free breathing
6 mm
Stitch

Transverse
T2 single shot 2 stacks
48 cm z axis
Abdomen -trigger
Pelvic - free breathing
6 mm
Stitch



- * Anatomical correlation
- * Exclude T2 shine-through
- * Characterize mucinous tumour
- * Detect Non DWI-avid lesions

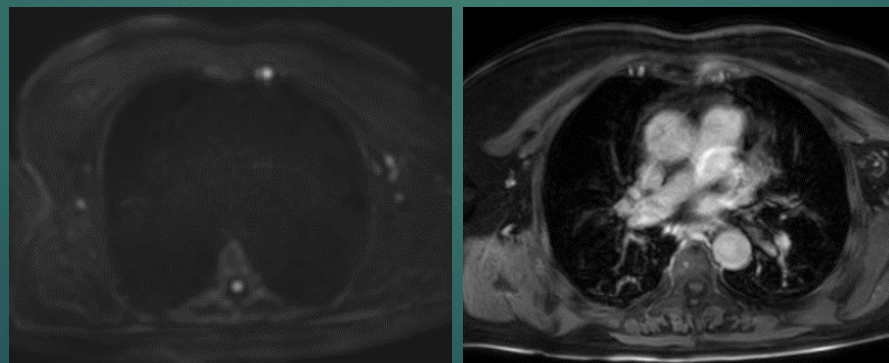
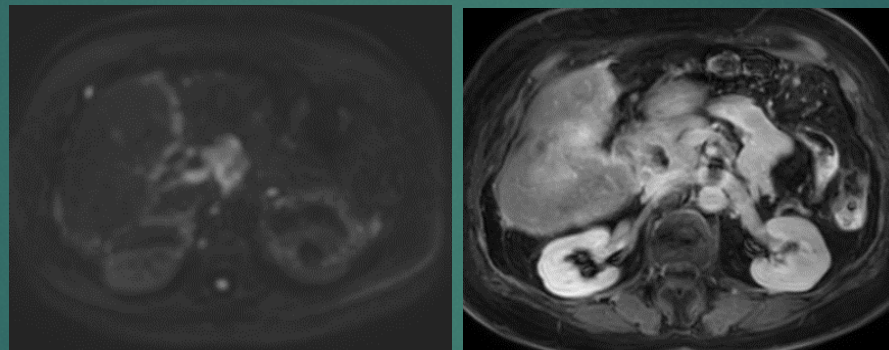
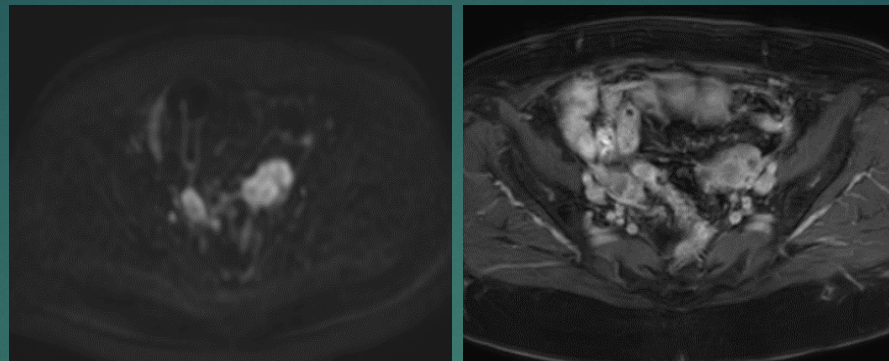
Fully replaces contrast imaging
when contra-indication

Image interpretation: sequence selection

The surgeon's best friend



Post-Gadolinium T1 gradient-echo
3-5 minutes post-injection
Breath-hold
Pelvis/abdomen:
transverse/Coronal
Chest: transverse
3 mm



- * Anatomical correlation
- * Lesion detection < 4 mm
= spatial resolution limit of DWI
- * Non DWI-avid lesions

Signet cell cancer

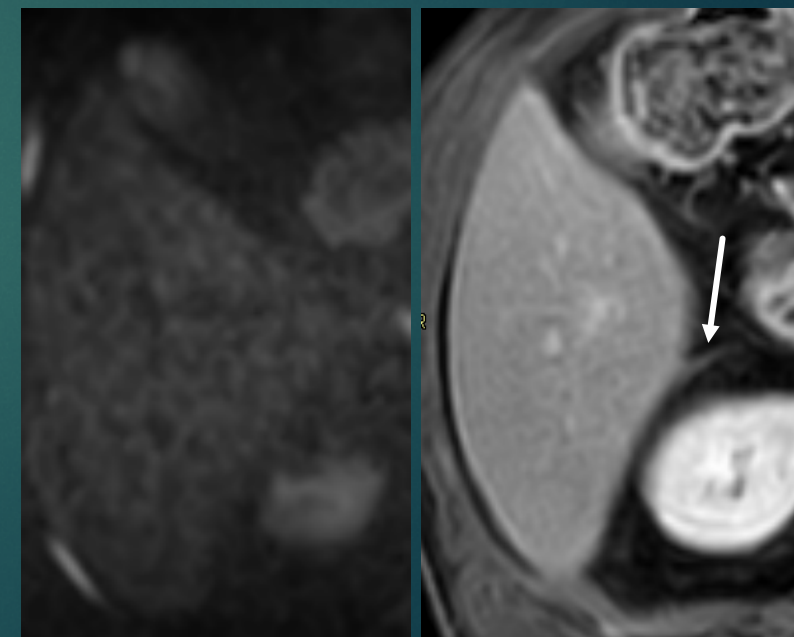
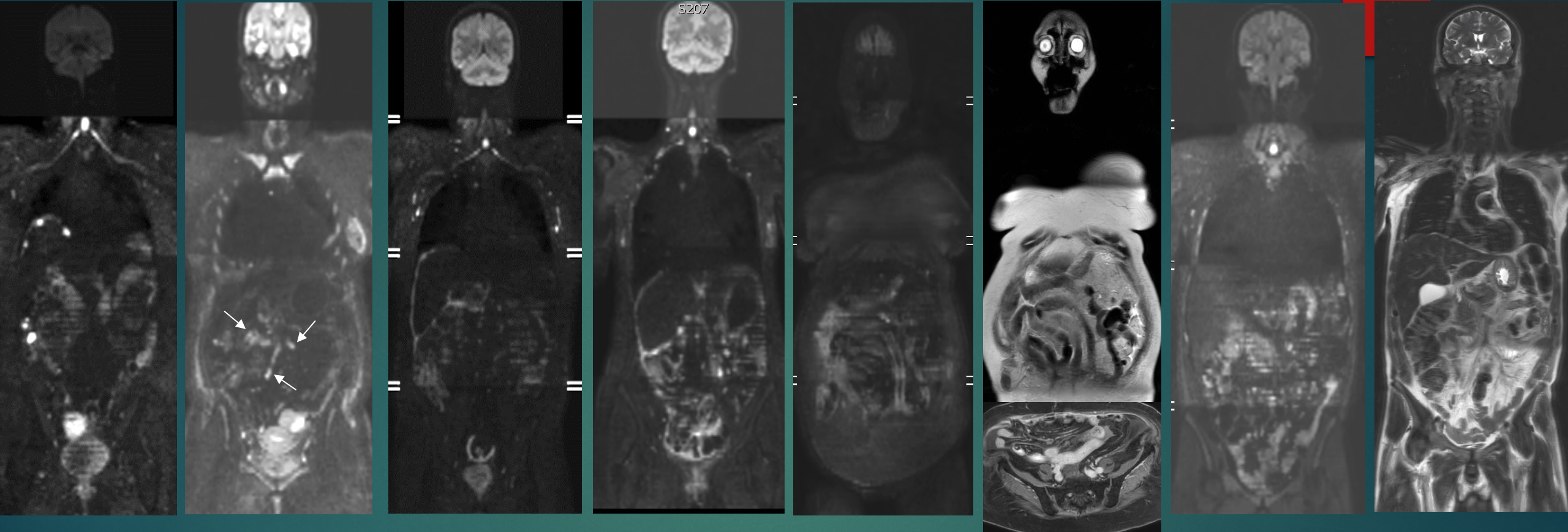


Image interpretation: b1000 + anatomical correlation



Nodular pattern

Confluent pattern

miliary pattern

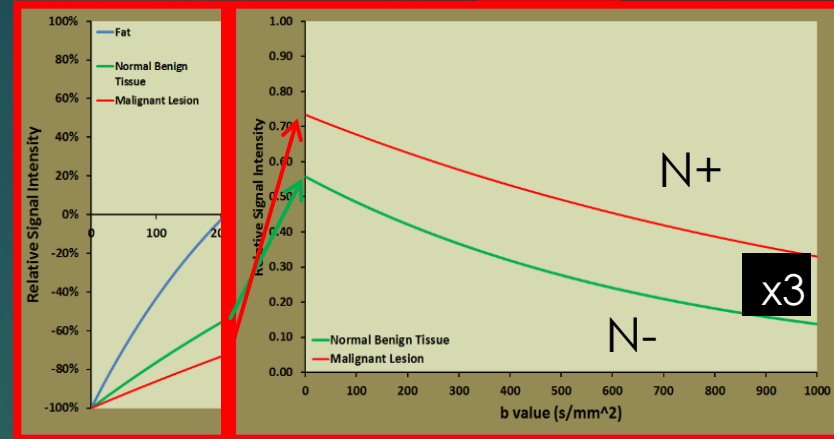
Infiltrative pattern

High grade ovarian – colorectal cancer

Lobular, low grade ovarian –
gastric pancreatic cancer

Lymph nodes - lymphadenopathies

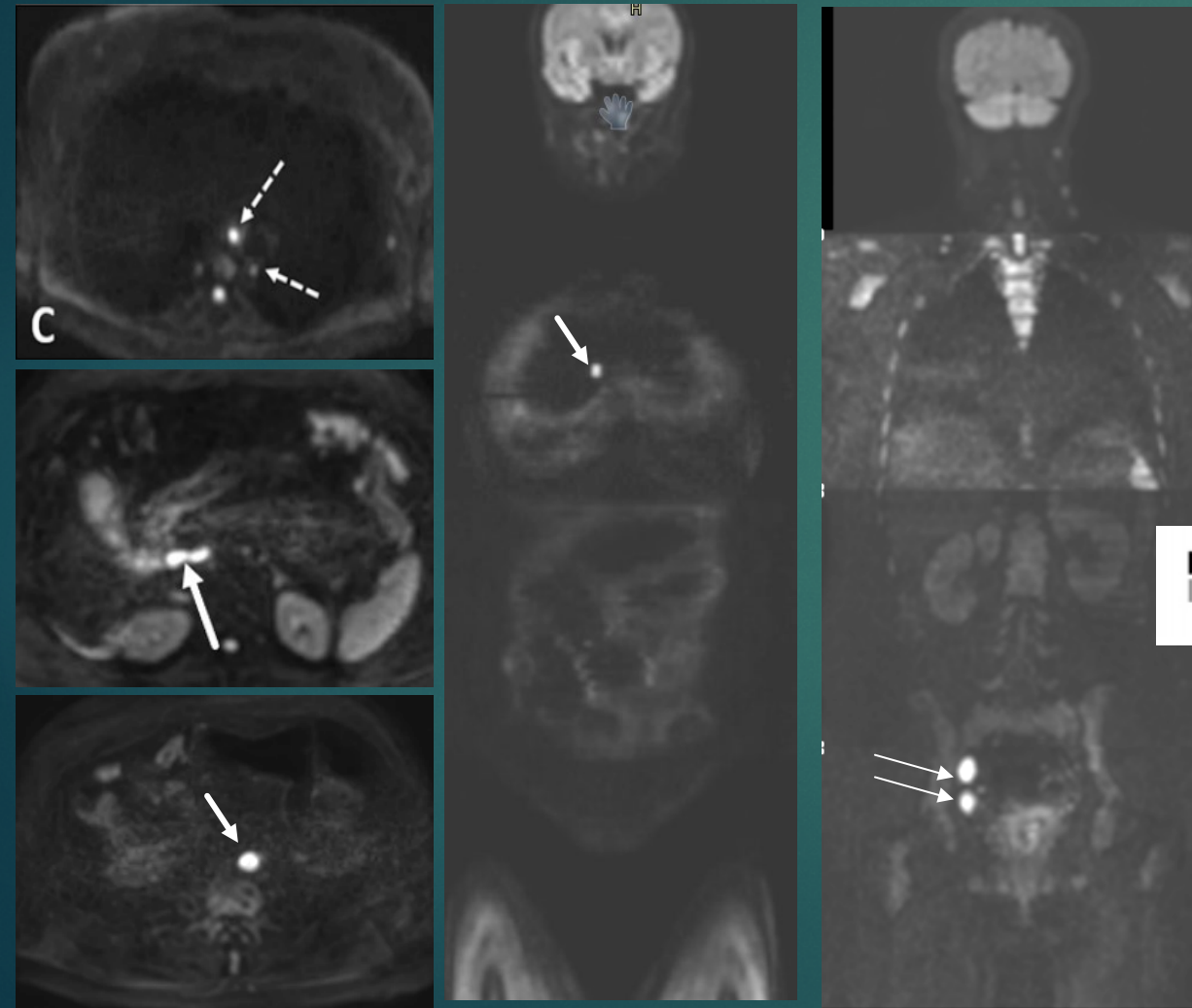
- ✓ Extra benefit of STIR = T1 based prepulse:
- ✓ Malignant lesions have a higher T1 than benign + better suppression of benign tissue
- ✓ Facilitates qualitative interpretation of lymph nodes



N+: SI ≥ primary tumor
 N- : SI < than primary tumor

+

N+: SI SI ≥ primary tumor surrounding lymph nodes
 N- : SI ≈ surrounding lymph nodes



WB-DWI-MRI
 CT

Modality	TP	FN	FP	TN	Sens	Spec	PPV	NPV	Acc
WB-DWI-MRI	51	13	0	31	7	86.3	(73.7-94.3)		
CT	51	8	0	31	12	76.5	(62.5-87.2)		

Rizzo S et al, Eur J Radiol 2020

Retroperitoneum	TP	FN	FP	TN	Sens	Spec	PPV	NPV	Acc
WB-DWI/MRI	10	3	3	29	0.77	0.91	0.77	0.91	0.87
CT	7	6	7	25	0.54	0.78	0.50	0.81	0.71
FDG-PET/CT	10	3	3	29	0.77	0.91	0.77	0.91	0.87

ovarian cancer 161 patients (Michielsen et al; Eur J Cancer 2017)

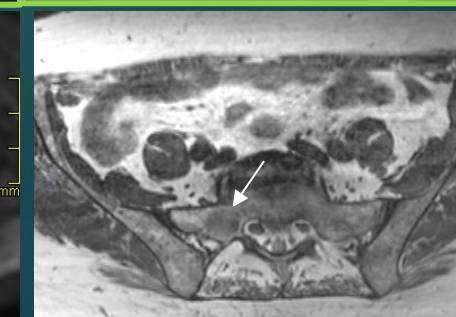
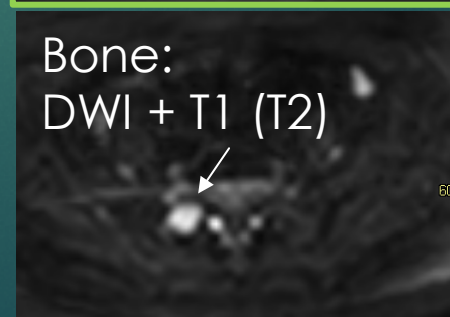
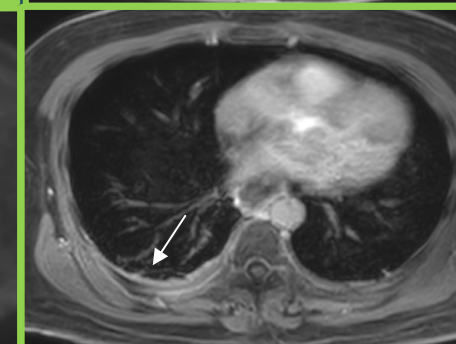
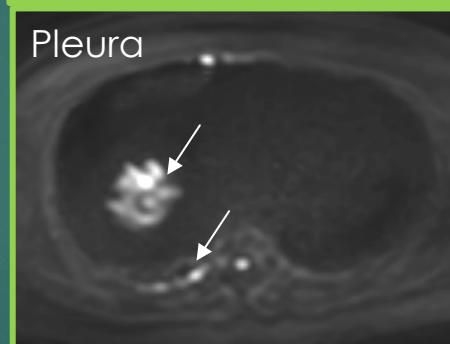
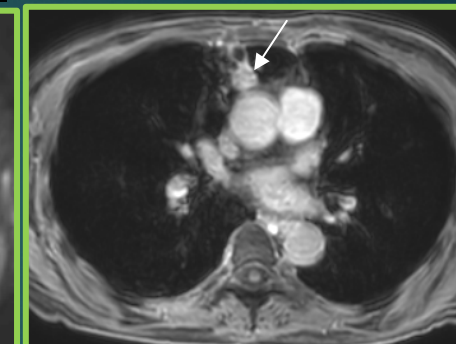
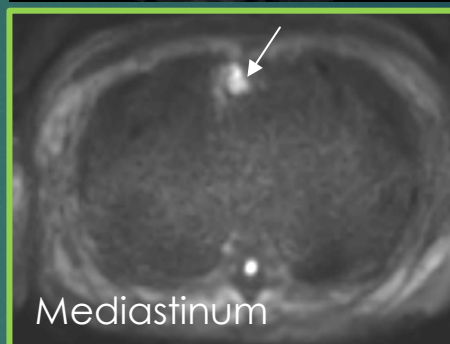
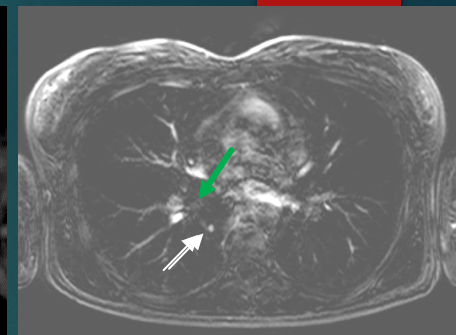
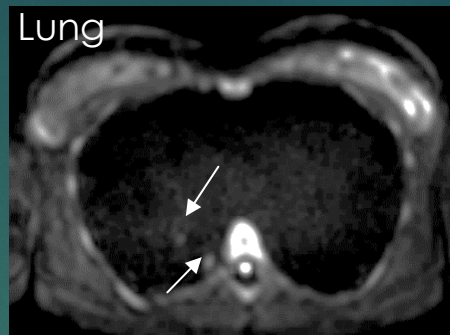
Image interpretation: Distant metastases/lymphadenopathies

Table 2
Weighted summary of sensitivity, specificity, and OR for each

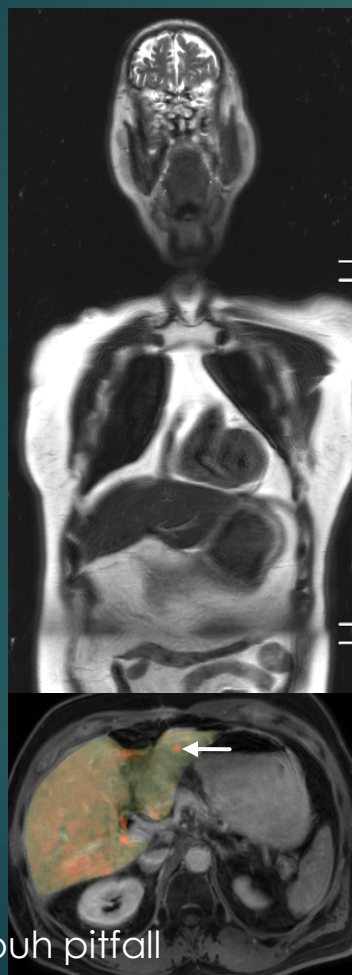
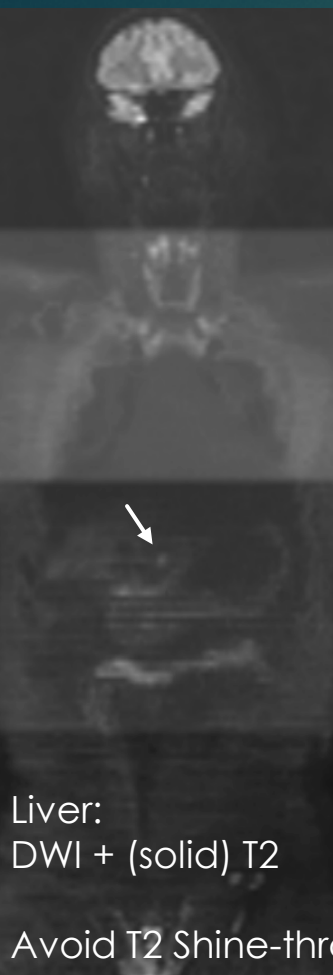
	Sensitivity	Specificity
WB-DWI		
Pooled estimates	0.897	0.954
95%CI	0.876-0.916	0.944-0.962
P value*	P=0.000	P=0.000
I ² value	85.60%	91.40%
WB-PET/CT		
Pooled estimates	0.895	0.975
95%CI	0.865-0.920	0.966-0.981
P value*	P=0.000	P=0.000
I ² value	90.40%	83.40%

lung metastases?

- + Equal performance as CT Per patient basis
- Lower performance Per-lesion basis



Bin L et al, Eur J Radiol



ORIGINAL ARTICLE
Detection Rate, Location, and Size of Pulmonary Nodules in Trimodality PET/CT-MR
Comparison of Low-Dose CT and Dixon-Based MR Imaging
Paul Stolzmann, MD, Patrick Veit-Hatbach, MD, Natalie Chuck, MD, Cristina Rossi, PhD, Thomas Frauenfelder, MD, Hatem Alkadhi, MD, MPH, Gustav von Schulthess, MD, PhD, MD(Hon), and Andreas Boss, MD, PhD

Low-dose CT	No. and Size (mm) of Nodules	
	WO MRI	IP
n = 66	n = 56	n = 58
19 (19; 2-69)	18 (18; 2-64)	17 (17; 2-67)
n = 36	n = 33	n = 35
32 (18; 3-69)	28 (16; 6-64)	28 (16; 5-67)
n = 30	n = 23	n = 23
5 (5; 2-30)	6 (10; 2-50)	5 (4; 2-24)

Low-dose CT	Patient-Based Detection Rates (n = 40)	
	WO MRI	IP
34/40; 85%	33/40; 83%	33/40; 83%
26/40; 65%	25/40; 63%	25/40; 63%
18/40; 45%	18/40; 45%	18/40; 45%

Liver: DWI + (solid) T2

Avoid T2 Shine-through pitfall

1/ Confirm primary origin

Miguez González et al. *Insights into Imaging* (2023) 14:115

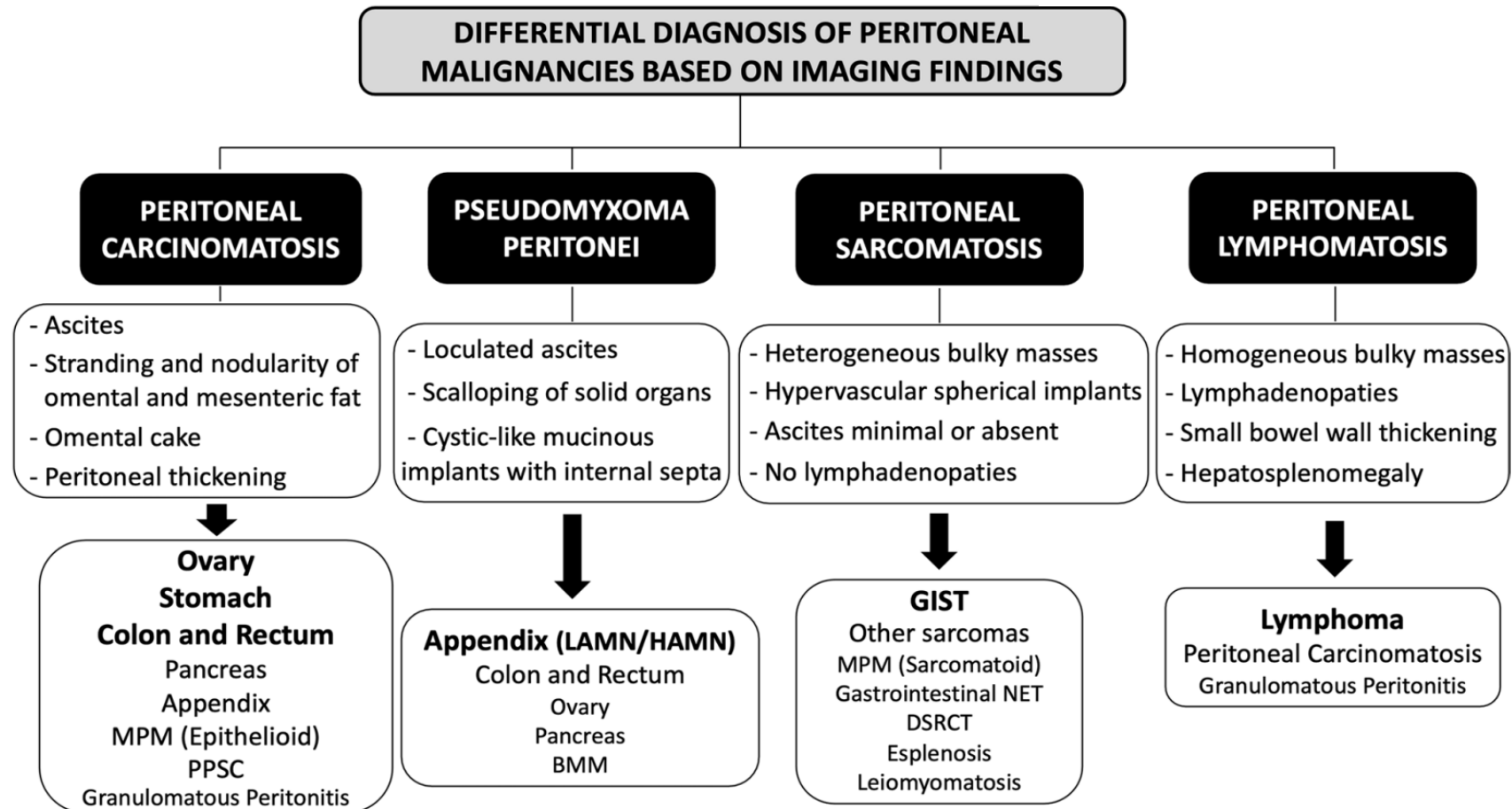
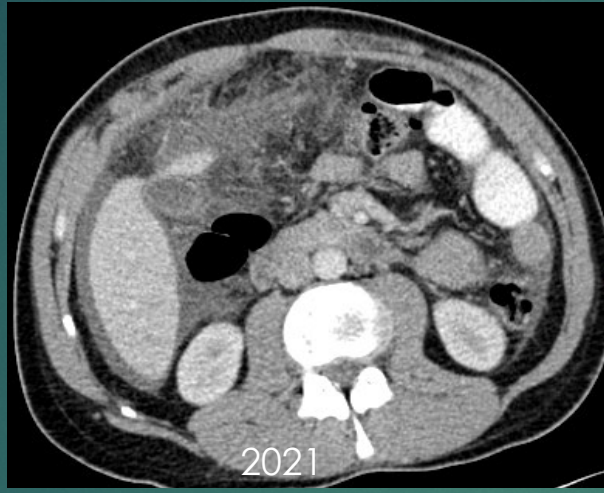
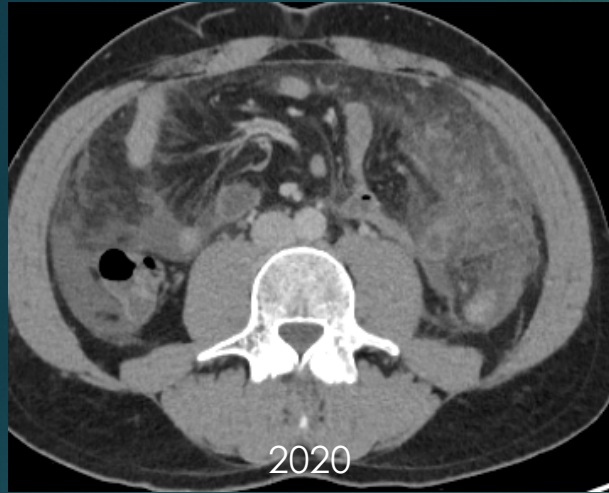


Fig. 36 Differential diagnosis of peritoneal malignancies based on imaging findings. MPM = Malignant Peritoneal Mesothelioma, PPSC = Primary Peritoneal Serous Carcinoma, LAMN = Low-Grade Appendiceal Mucinous Neoplasm, HAMN = High-Grade Appendiceal Mucinous Neoplasm, BMM = Benign Multicystic Mesothelioma, NET = Neuroendocrine Tumor, DSRCT = Desmoplastic Small Round Cell Tu

- Ddx of primary from metastatic peritoneal tumours is non-straightforward
- Histopathology after core biopsies required for final diagnosis → obliged in neoadjuvant chemotherapy
- Knowledge of radiological features that can guide initial diagnosis → impact management

1/ Confirm primary origin: malignant mesothelioma

Patient 41 years old, over years periods of acute abdomen, relieved with corticoids/NSAID



Mesenteritis? - IgG4 inflammatory disease?

MRI:

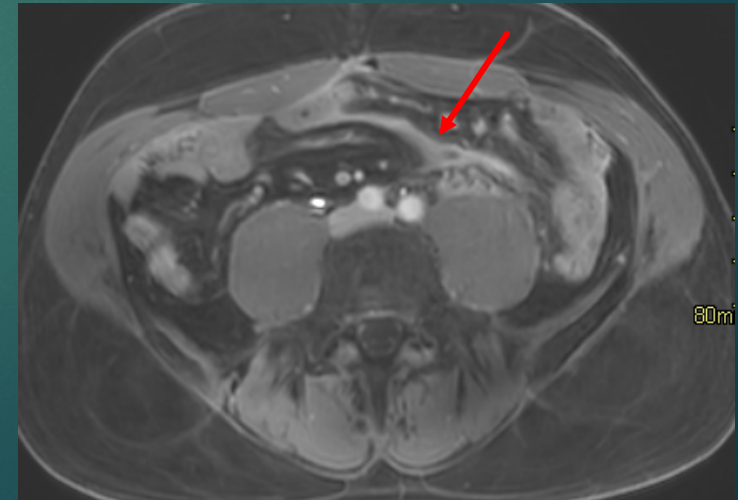
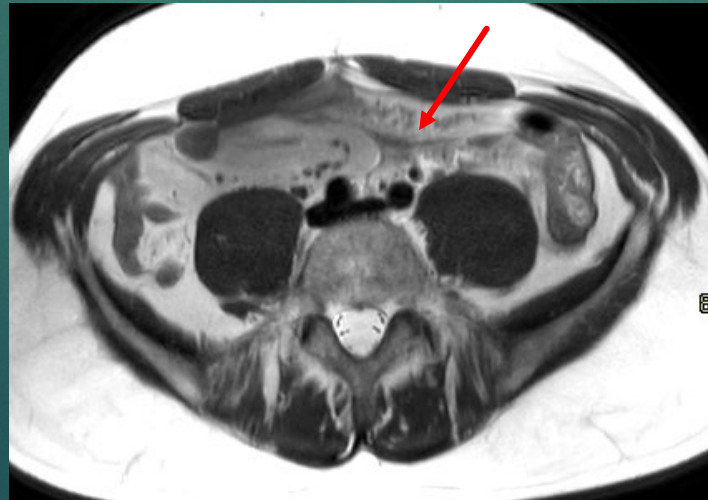
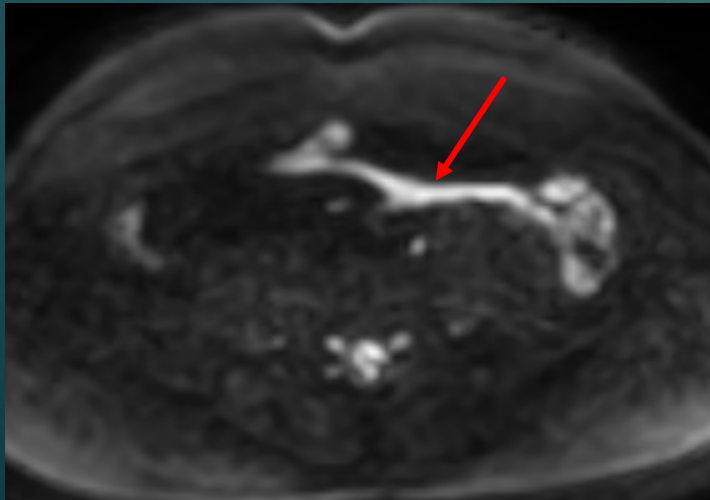
- *Operability? → predicts incomplete resection
- *Primary tumour? → none found

Laparoscopy:

- *Operability predicts complete resection
- * Histopathology after biopsy: malignant mesothelioma

Incomplete debulking surgery followed by atezolizumab

Best treatment appears corticoids/NSAID in 2024



1/ Confirm primary origin: malignant mesothelioma

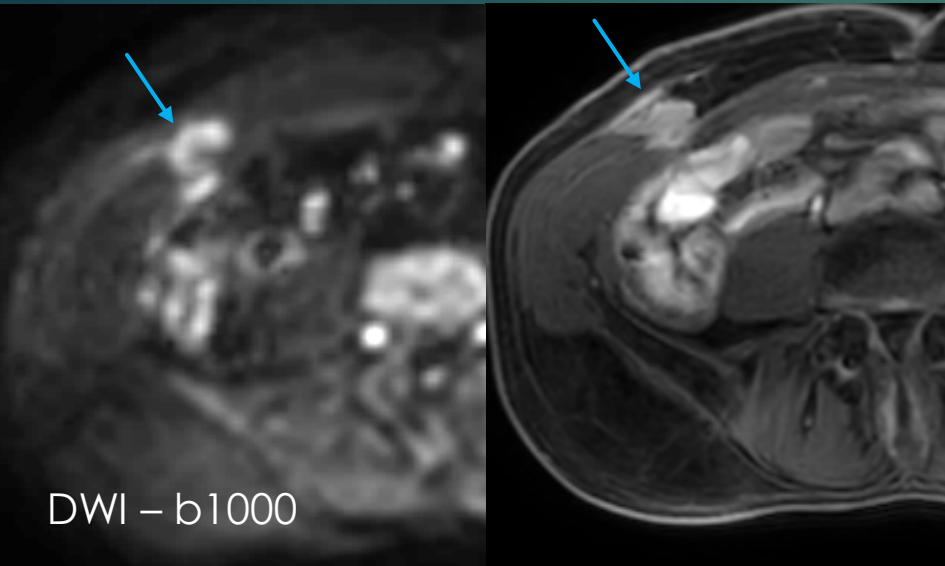
Clinical context:

Men 60% – Women 23% asbestosis exposure – 30% simultaneous pleural involvement

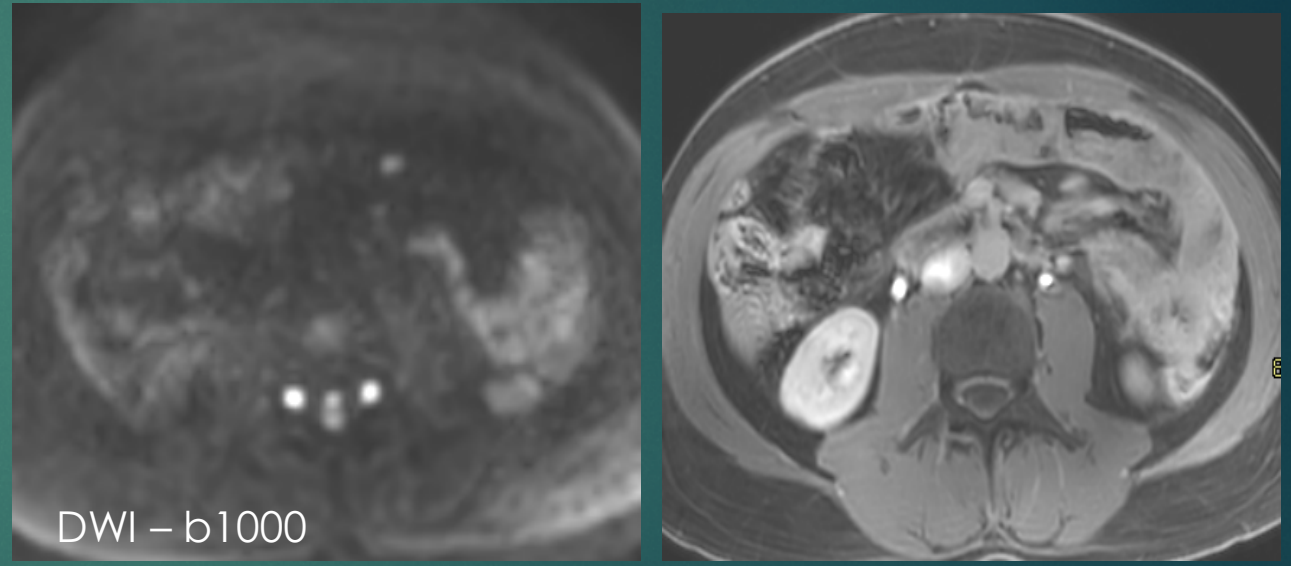
Men (median 60 years) > women (median 50 years)

Occasionally seen in young patients without exposure history

Non-specific abdominal discomfort, pain, local palpable mass



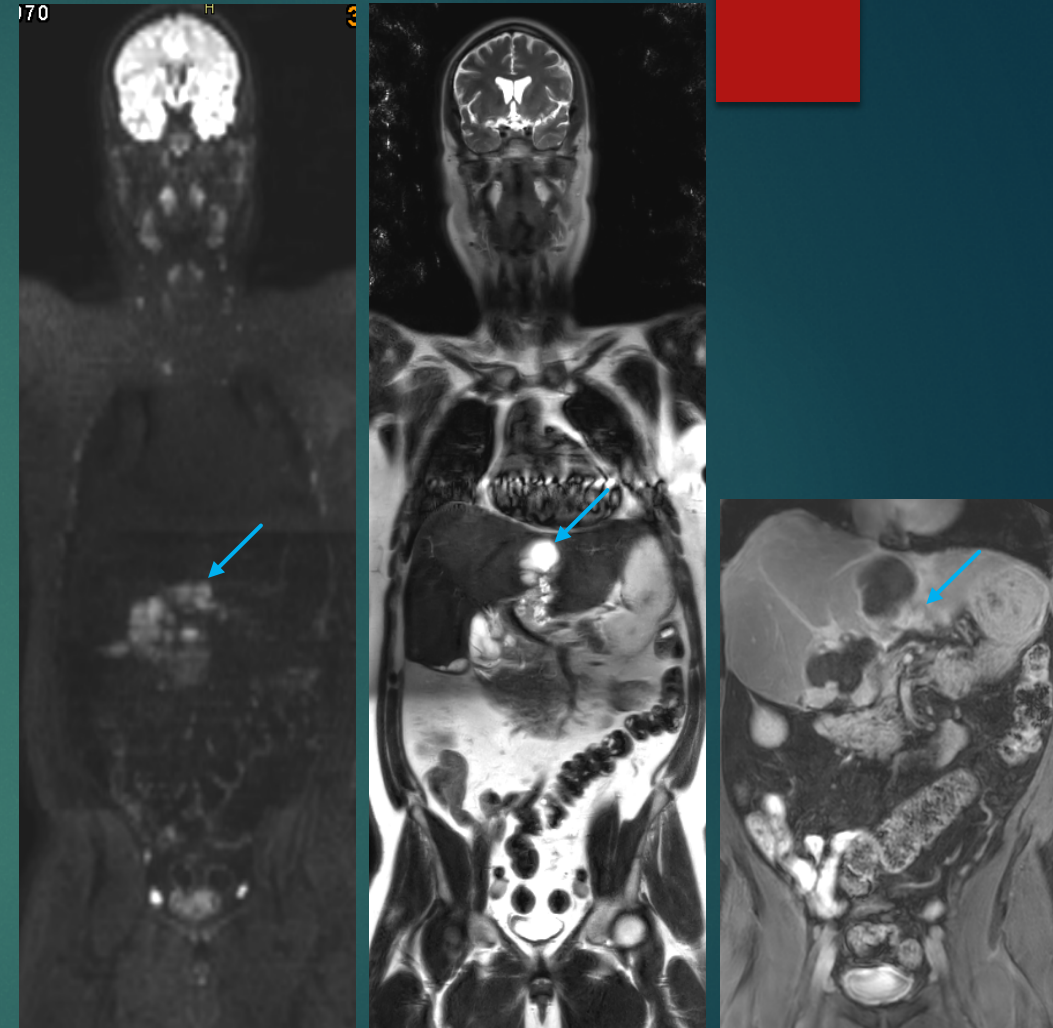
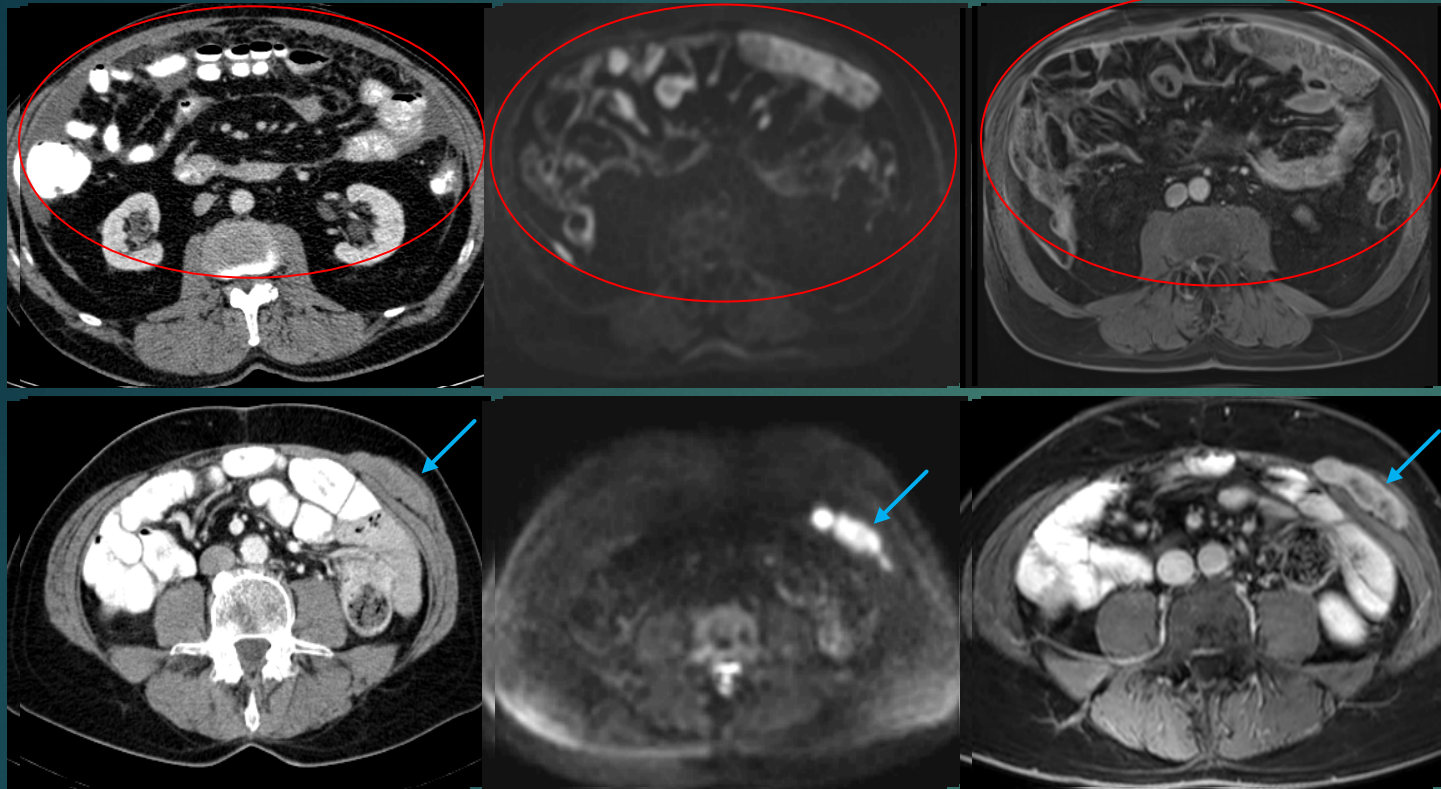
Sarcomatoid type: solid masses
“sarcomatoid” appearance



Epitheloid type: infiltrative, small nodules, multifocal
“carcinomatosis” appearance

Imaging appearance does not strictly predict histological tumor type (mixed types)

1/ Confirm primary origin: malignant mesothelioma



Main imaging feature:

Contrast-enhancement at CT and MRI: conspicuous at both modalities

Cystic component due to mucinous component or degeneration

DWI b1000 +++ in the tumoral component,

Absent DWI b1000 allows distinction of inflammatory component

Differential diagnosis → histopathological diagnosis

As opposed to:

- Peritoneal metastases
- Infections like tuberculosis



Consider when:

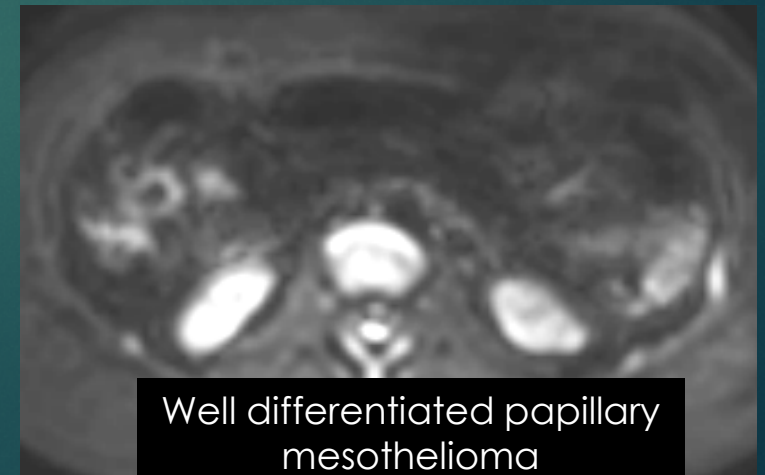
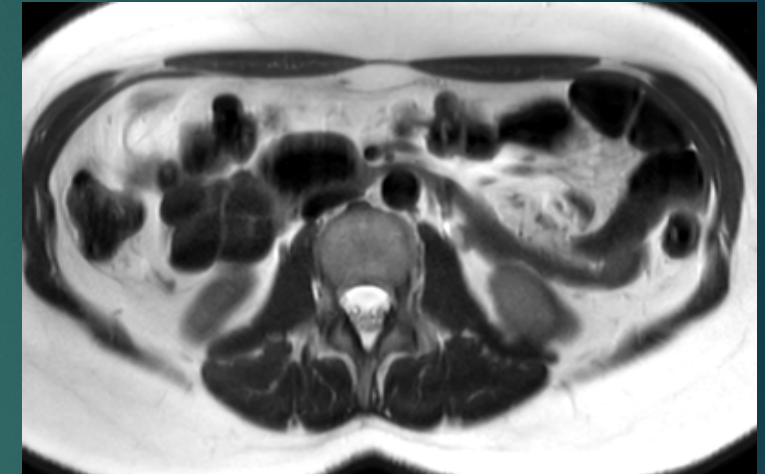
Absence of primary tumour; lymphadenopathies and visceral metastases
Sheetlike thickening of peritoneum or sarcomatosis-like appearance
Signs of asbestosis exposure

As opposed to:

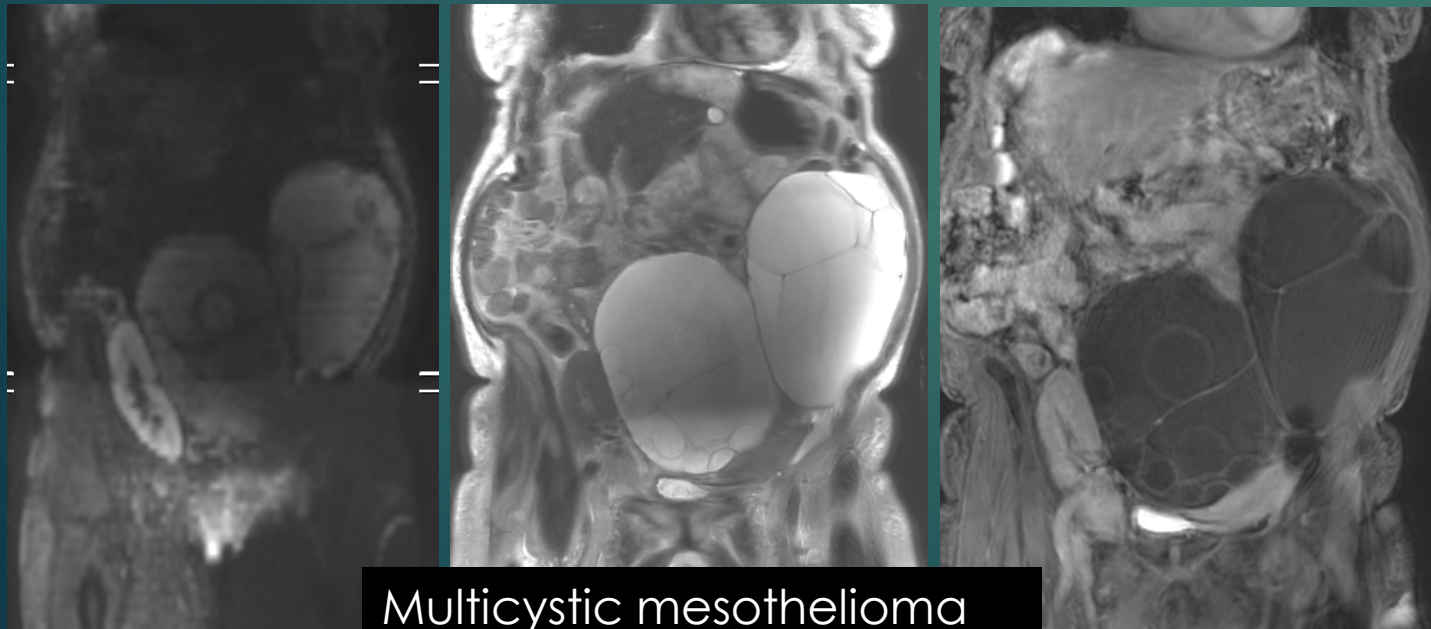
- Well-differentiated mesothelioma
- Multicystic mesothelioma
(uncertain malignant potential)



No diffusion restriction
Simple cystic nature
No enhancement



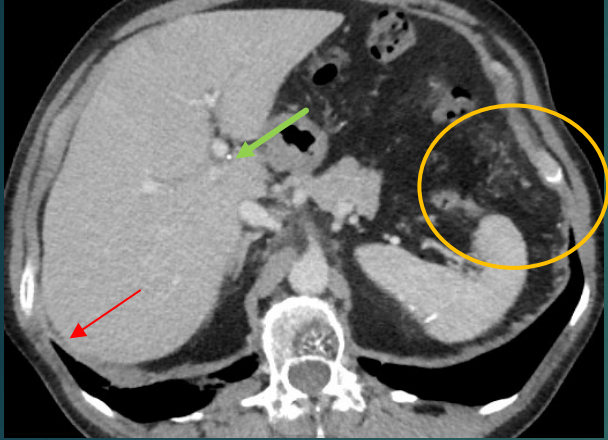
Well differentiated papillary mesothelioma



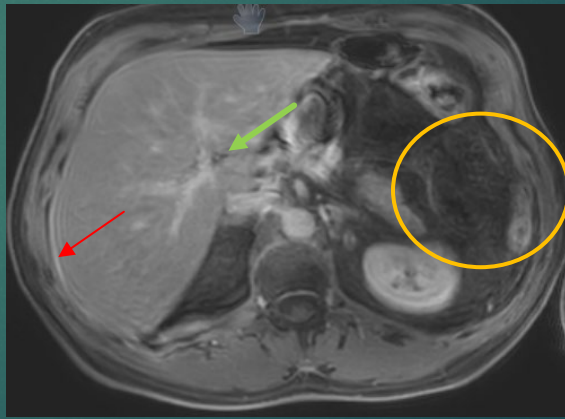
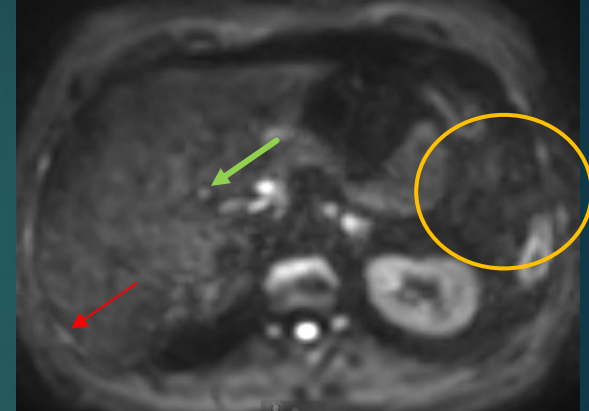
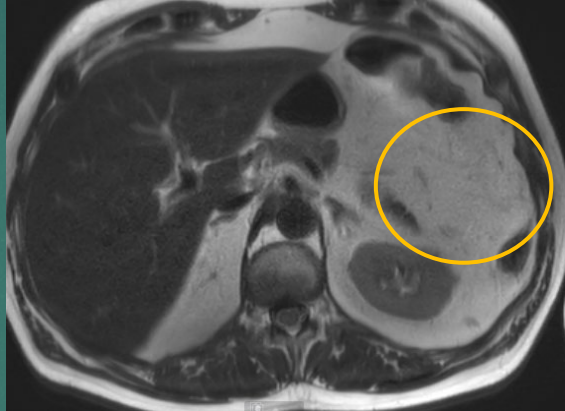
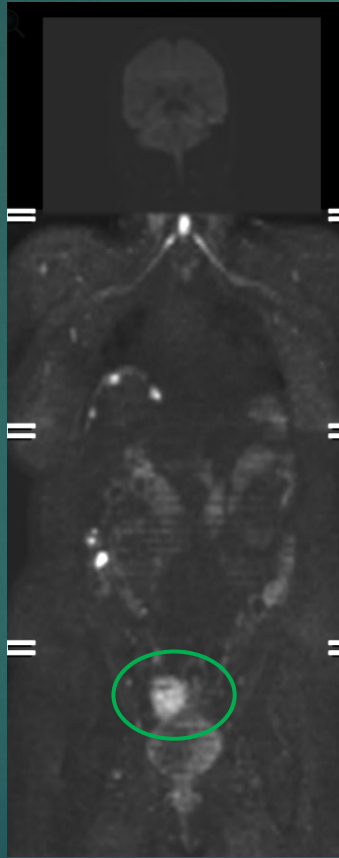
Multicystic mesothelioma

1/ Confirm primary origin: Primary peritoneal papillary serous carcinoma

60 year old patient with bloating and vaginal bleeding.



Peritoneale calcifications



WB-DWI/MRI for staging operability

No identifiable primary tumour
Normal ovaries

Upfront debulking surgery to R0: Primary peritoneal papillary serous carcinoma

1/ Confirm primary origin: Primary peritoneal papillary serous carcinoma

Women aged between 50 and 60 years old.

Complaints of abdominal distention, pain, bloating, nausea and vomiting. Increase of CA-125

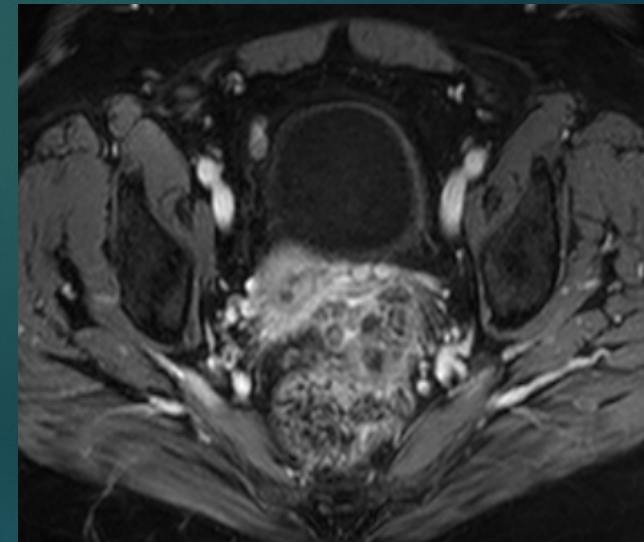
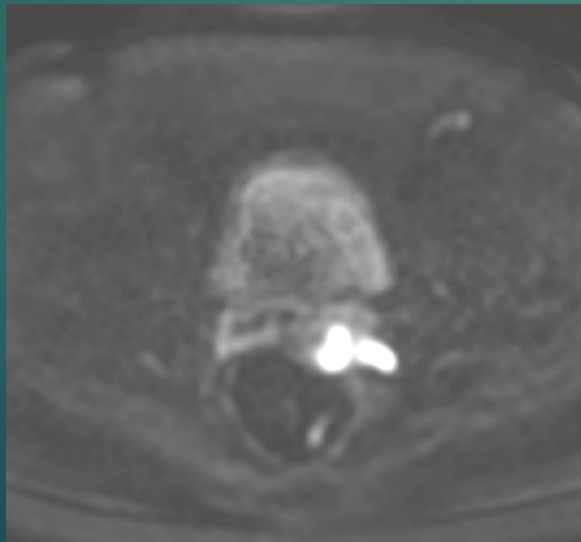
Histologically, immunohistochemically identical to metastatic serous ovarian carcinoma implants, but arises from extra-ovarian mesothelium with Mullerian potential

Treatment identical to ovarian cancer.

Imaging appearance overlaps with (low grade) ovarian cancer → no identifiable tumour at the ovaries. Overall, mimic peritoneal metastases of ovarian cancer.

Key imaging feature: psammomatous calcifications (up to 30% of patients) and absence of ovarian mass.

→ **Potential pitfall for MRI staging, calcified lesions less apparent.**



1/ Uncertain origin: Desmoplastic small round cell tumour

Men < 30 years (mean 19 years)

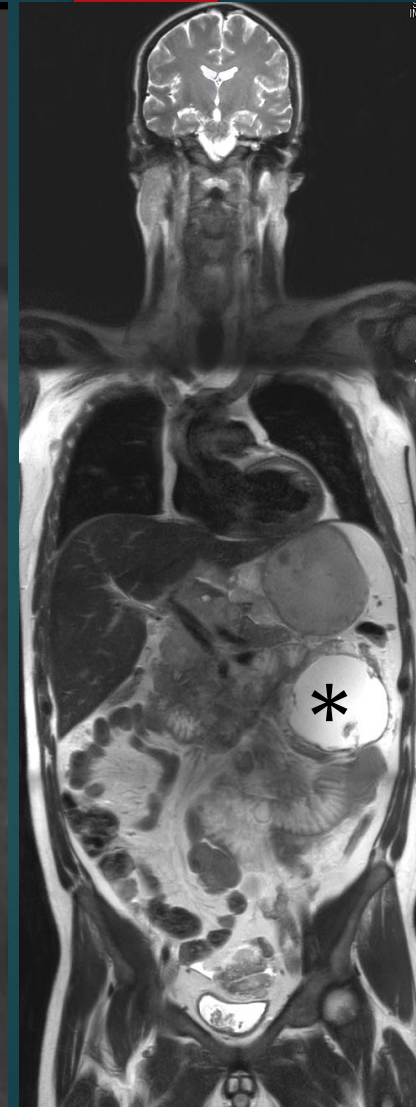
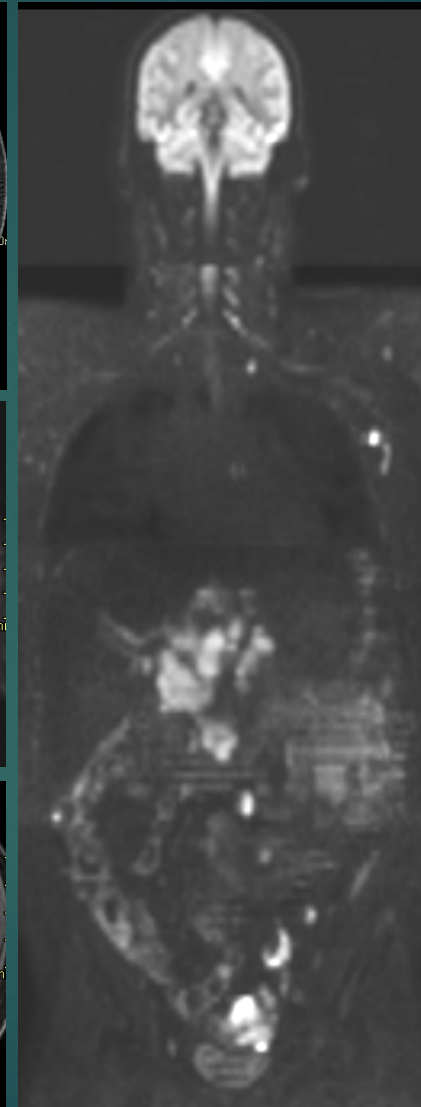
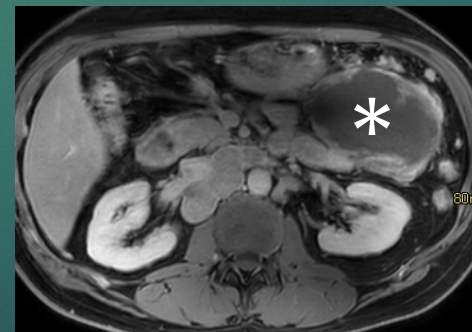
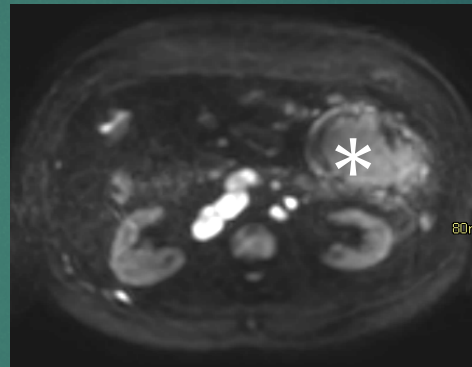
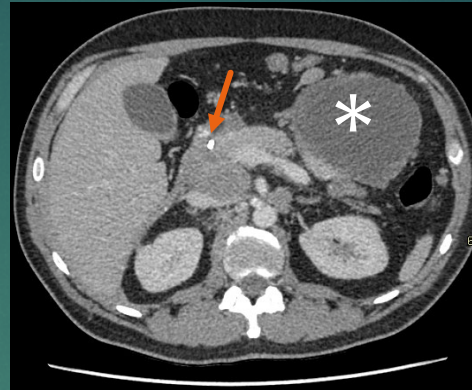
Non-specific abdominal complaints

Extremely rare

- Main imaging features:
- Diffuse peritoneal spread
- Dominant intraperitoneal tumour > 10 cm* with intratumoral necrosis
- Punctate calcifications in the tumoral masses ↴
- Commonly lymph node and visceral metastases

Differential diagnosis

Lymphomatosis > carcinomatosis



1/ Uncertain origin : disseminated peritoneal leiomyomatosis

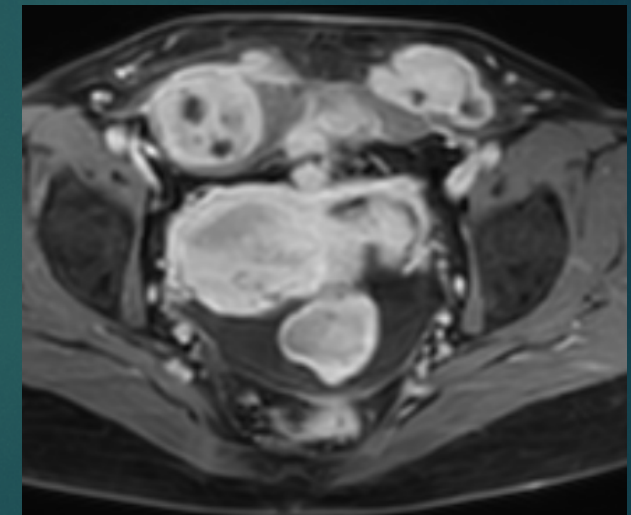
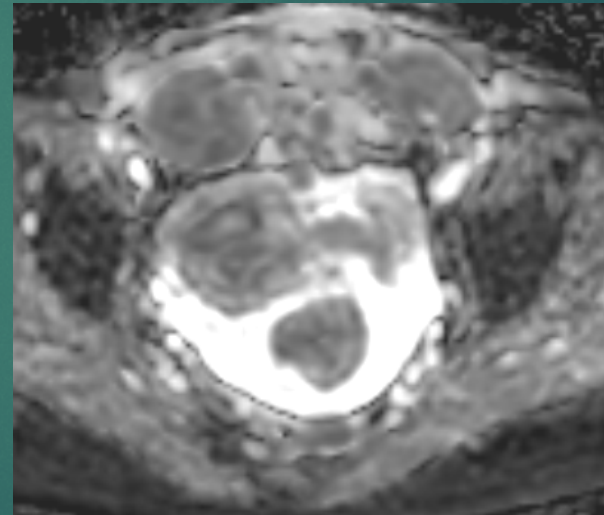
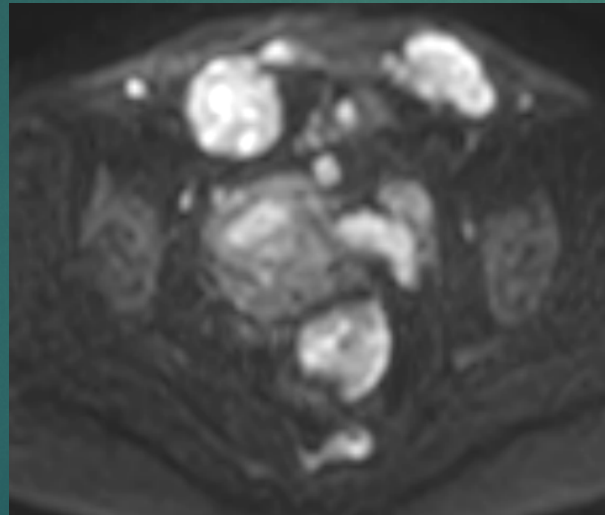
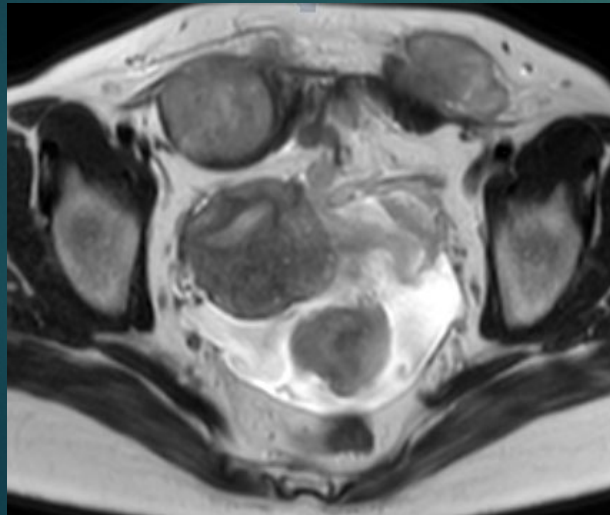
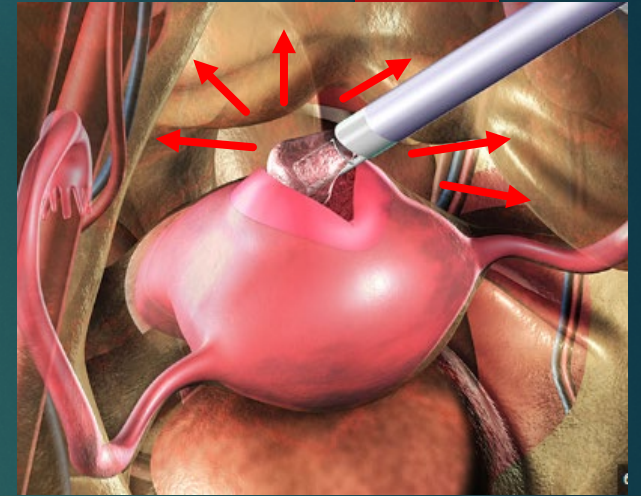
Smooth muscle nodules and masses in the peritoneal cavity.

Metaplasia of submesothelial smooth muscle

Risk factors : uterine leiomyoma, high oestrogen levels

prior hysterectomy or myomectomy

myoma morcellation



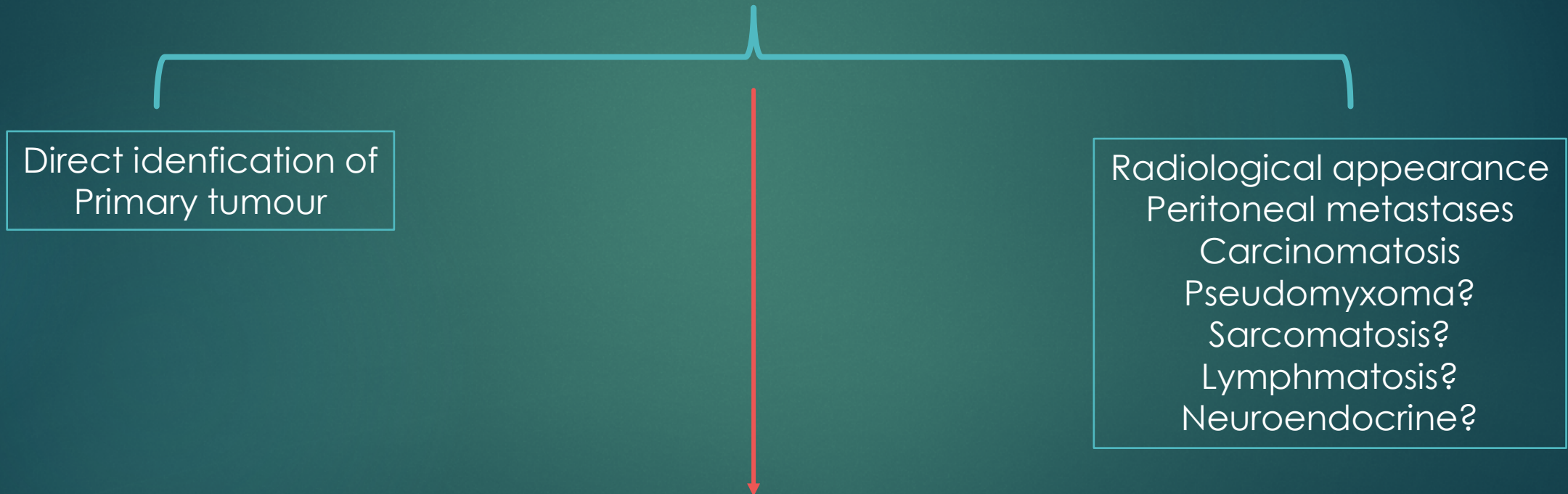
Key imaging feature: T2, contrast-MRI and DWI behave like myometrium – increased ADC

Differential diagnosis: Sarcomatosis, sarcomatoid mesothelioma

1/ Confirm primary ovarian malignancy (\leftrightarrow) exclude other cancer mimicking ovarian cancer

- Key process in initial treatment selection: primary ovarian, colon, pancreatic, gastric cancer, NET...
- B1000 + anatomy
- Often in the context of malignant ovarian mass \pm peritoneal metastases

Primary tumour identification in peritoneal carcinomatosis



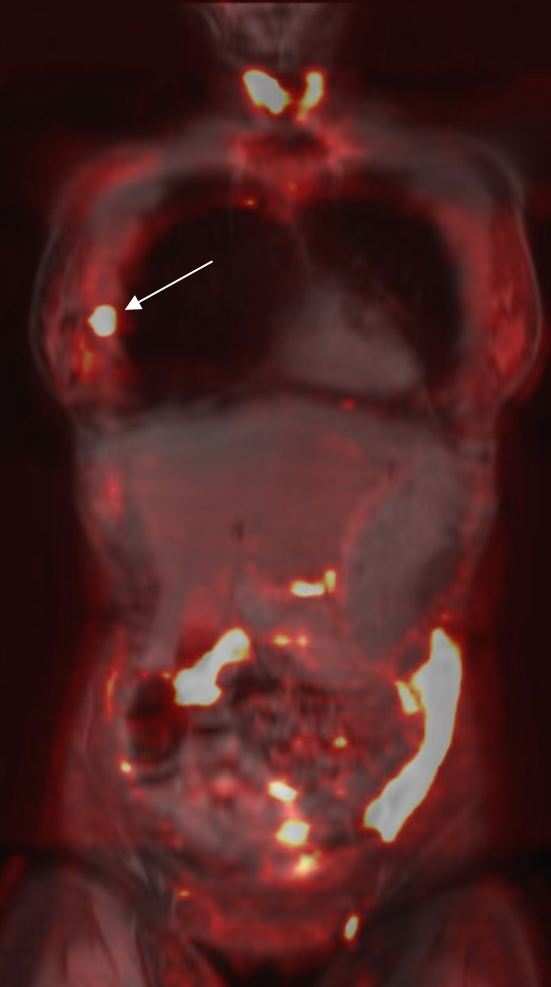
Atypical distribution of distant metastases: Liver, Bone, lung → Search for other primary than ovarian

Direct identification of primary

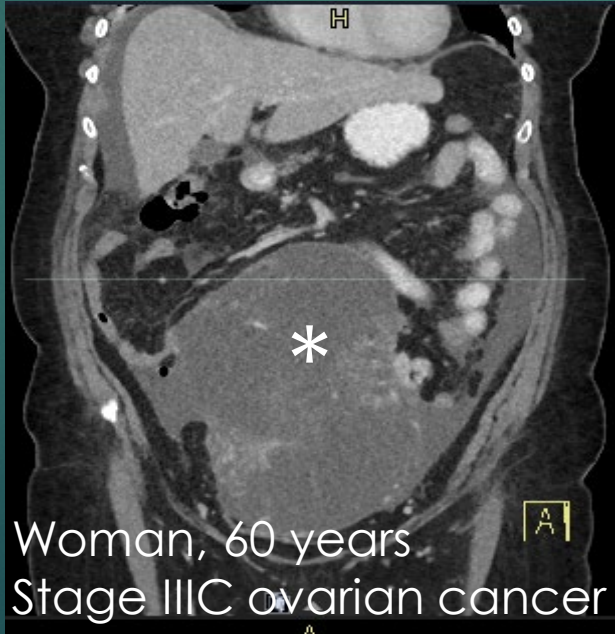
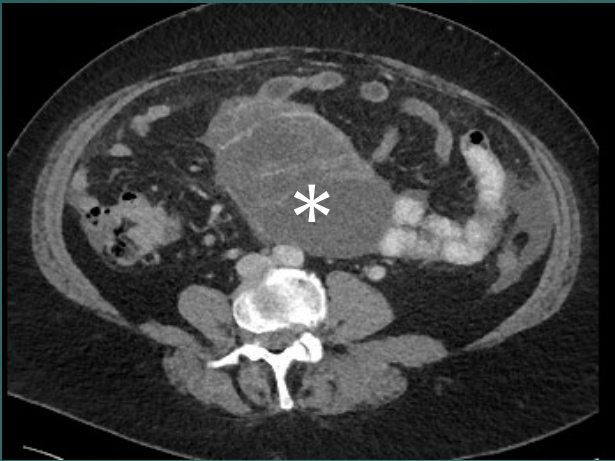
Fused b1000/DWI

Primary tumor ID: if ovarian mass
**** WB-DWI : 81% accuracy**
**** CT : 31% accuracy**

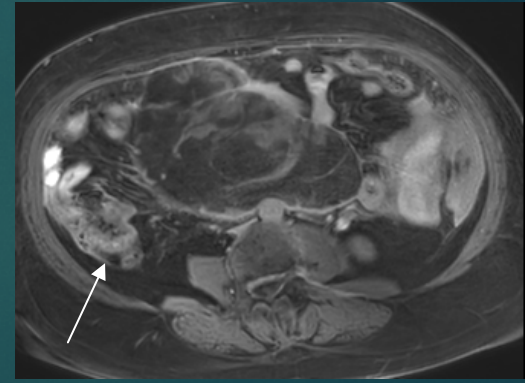
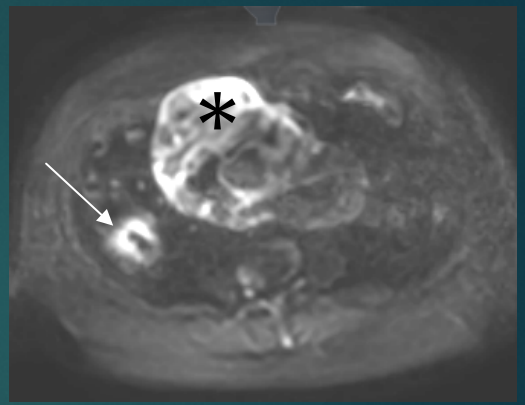
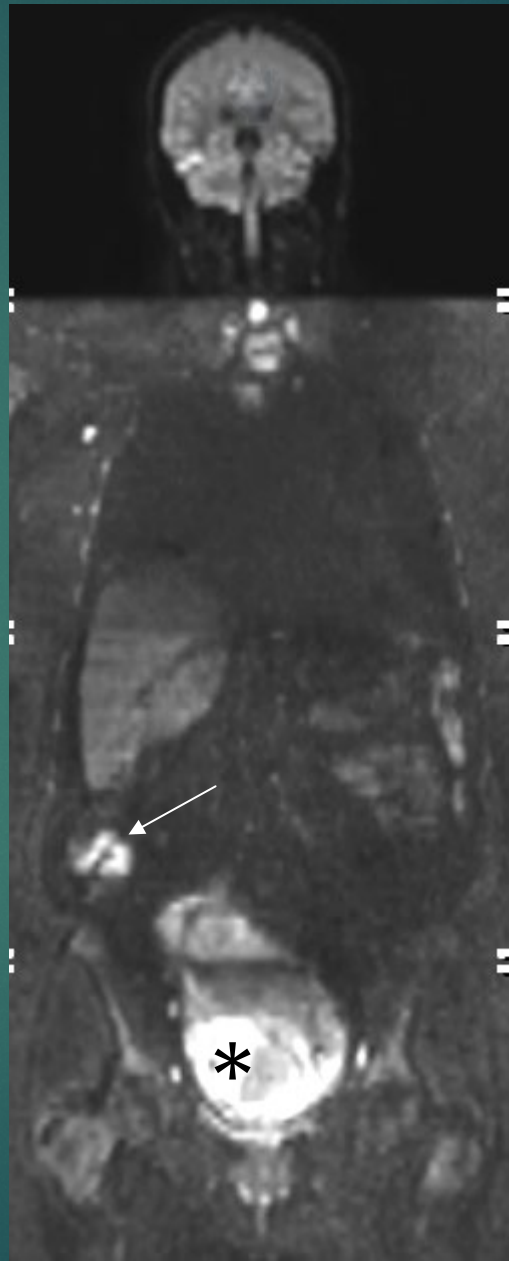
Michielsen K et al, EJC 2017



Ovarian cancer
Incidental breast cancer

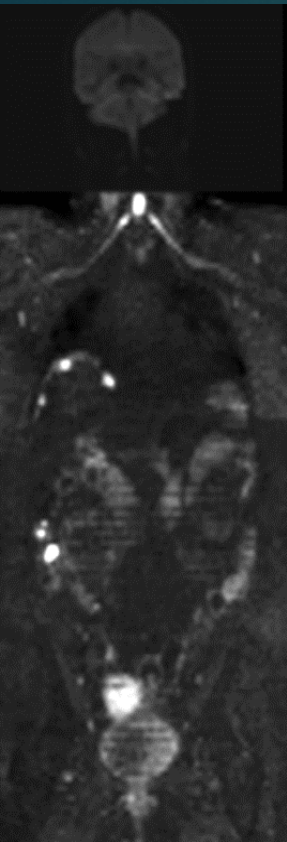


Woman, 60 years
Stage IIIC ovarian cancer

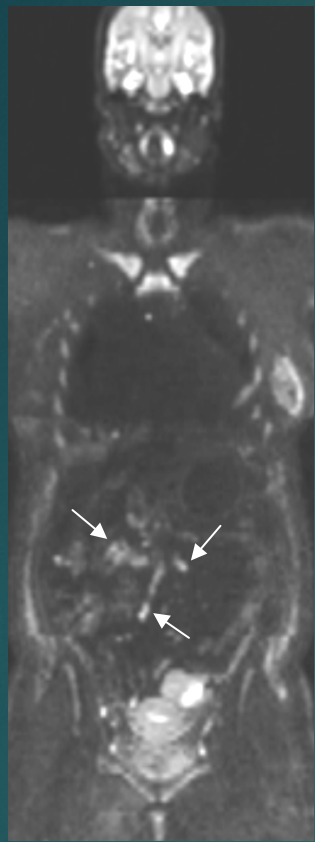


Coloncancer
Ovarian/peritoneal M+
PCI 13
Laparoscopy canceled
→Coloscopy

Radiological appearance of peritoneal metastases indicates primary?



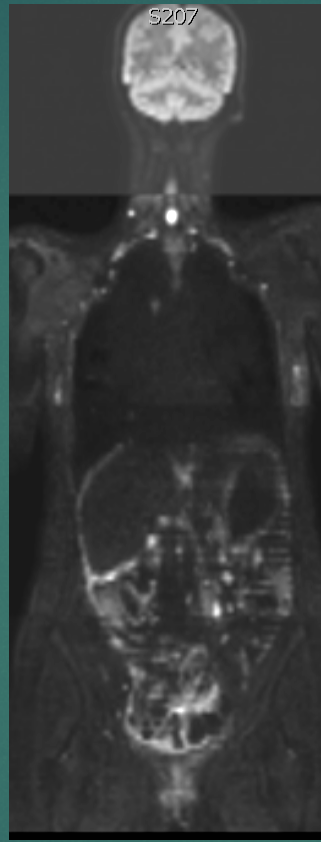
Nodular pattern



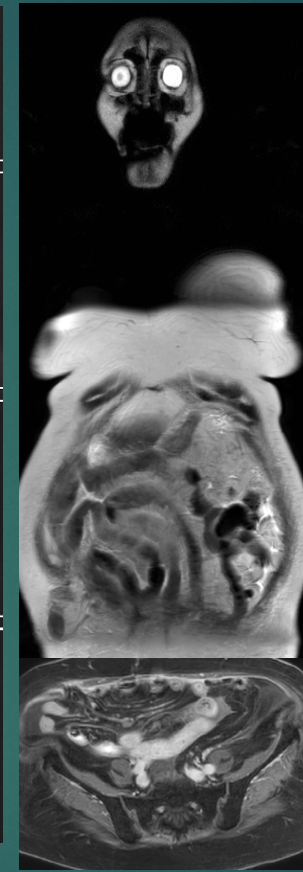
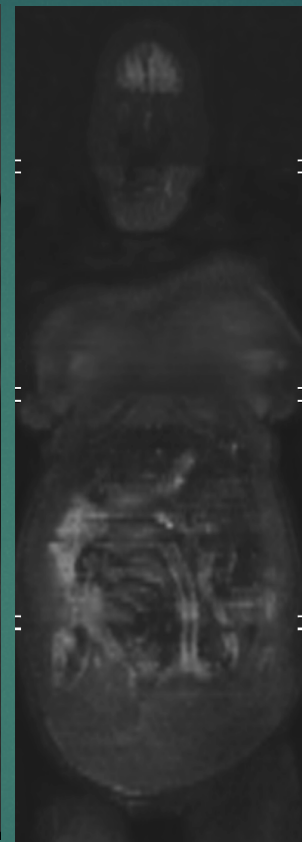
Confluent pattern



Infiltrative/miliary pattern



Signet ring cell pattern



Peritoneal carcinomatosis: Ovary, GI adenocarcinoma, **Gastric cancer**, Pancreas, lobular breast cancer
Pattern not tumour specific but often detectable primary tumour (previous slide).

Radiological appearance of peritoneal metastases indicates primary?

Pseudomyxoma peritonei:

Appendix: LAMN/HAMN ↙

Colon/rectum: mucinous - worse prognosis

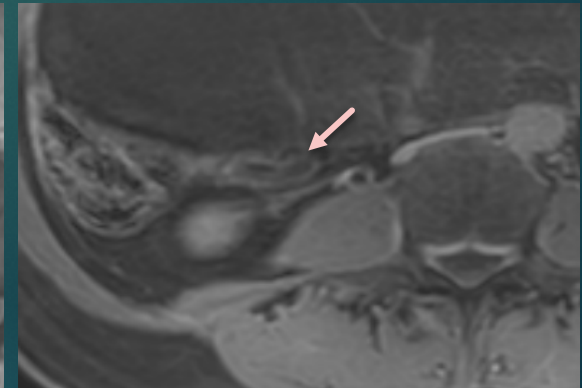
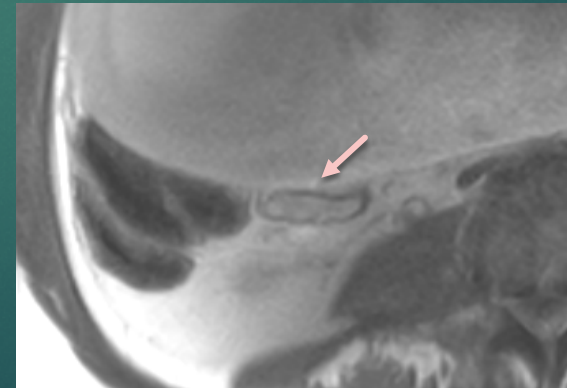
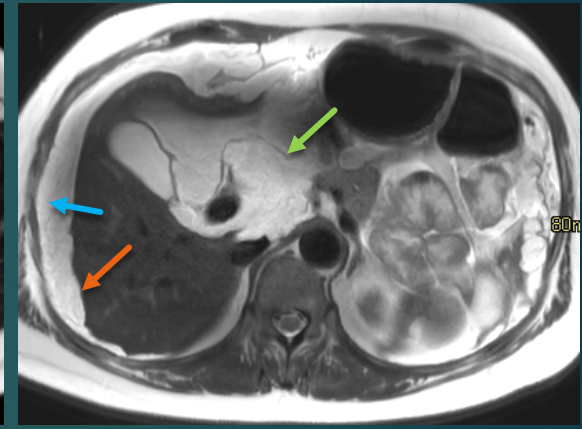
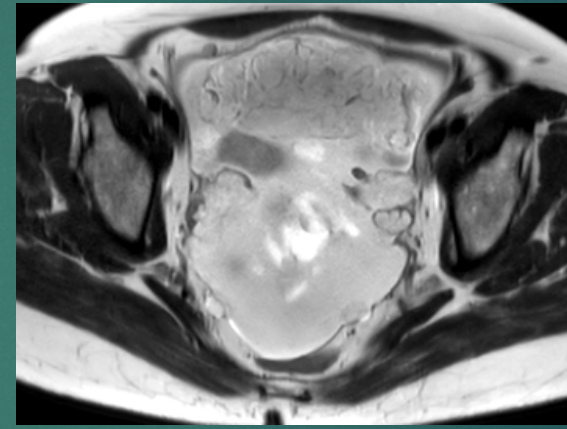
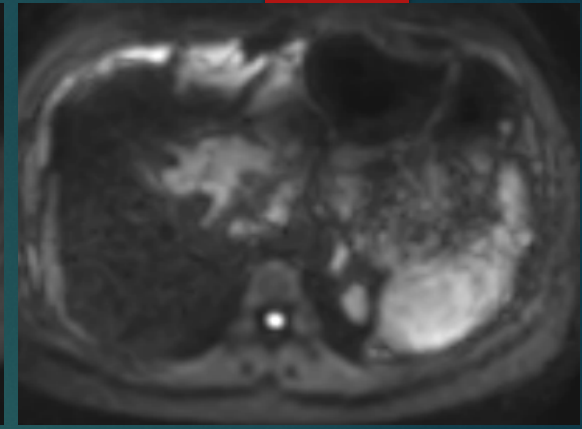
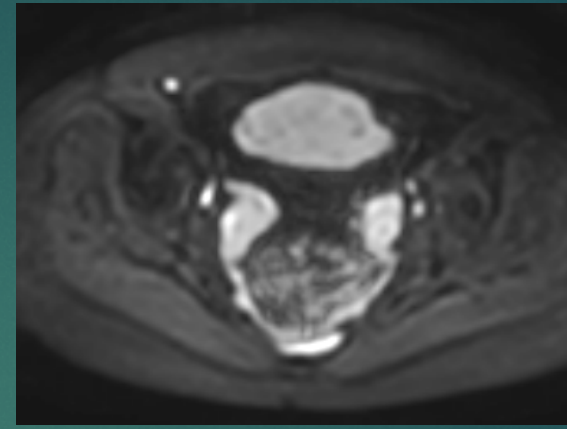
Ovary: mucinous - (rare) – Bad prognosis

Radiological features:

- Loculated ascites
- T2 -ADC halo at fluid/tissue interface ↘
- Scalloping of solid organs ↘
- Solid and Cyst-like implantes with internal septae. ↘

MRI > CT for detection mucinous implants

Main differential: Malignant mesothelioma
(Mucinous degeneration)



Radiological appearance of peritoneal metastases indicates primary?

Peritoneal sarcomatosis:

Heterogeneous group of tumours.



GIST: most frequent

Leiomyosarcoma

Liposarcoma (dedifferentiated and myxoid type)

Myxoid (lipo)sarcomas (even extremity although rare)

Key radiological features that allow differentiation:

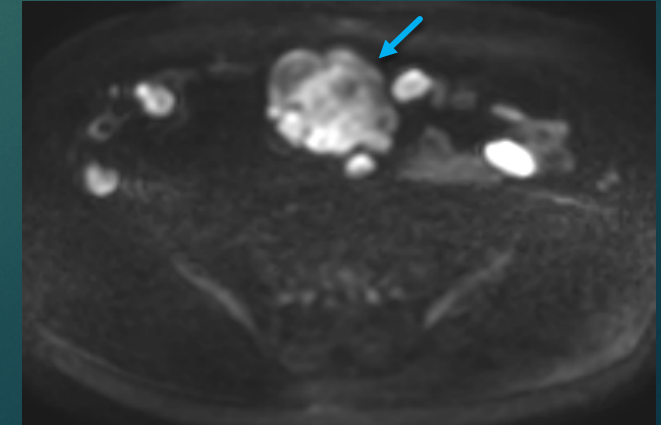
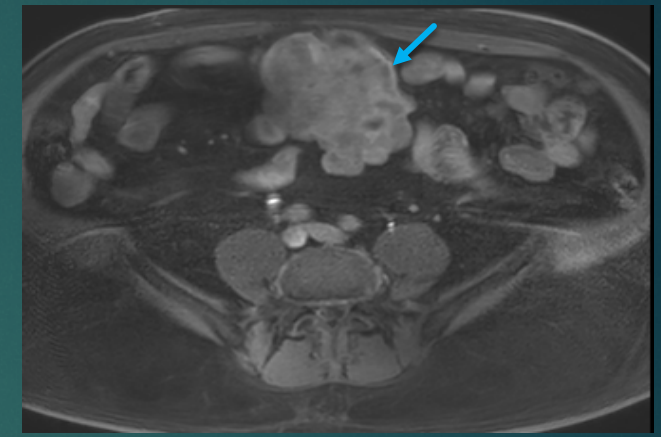
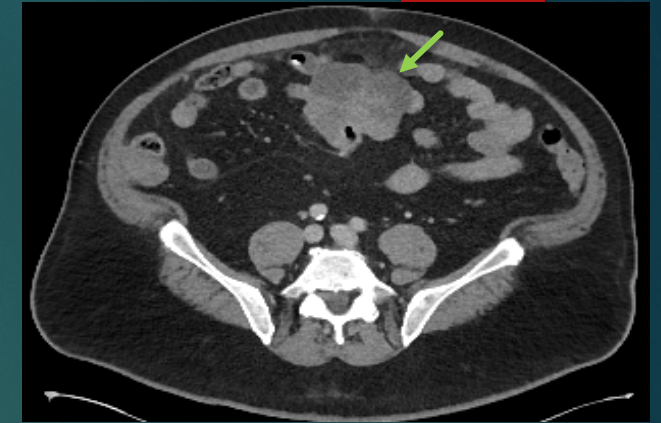
- Bulky solid masses 
- Hyperenhancement and DWI +++ 
- Fat content (liposarcoma)
- Myxoid appearance (Myxoid sarcoma)

→ MRI > CT to characterize and stage lesions

Detection more important than staging for operability assessment (exception for GIST).

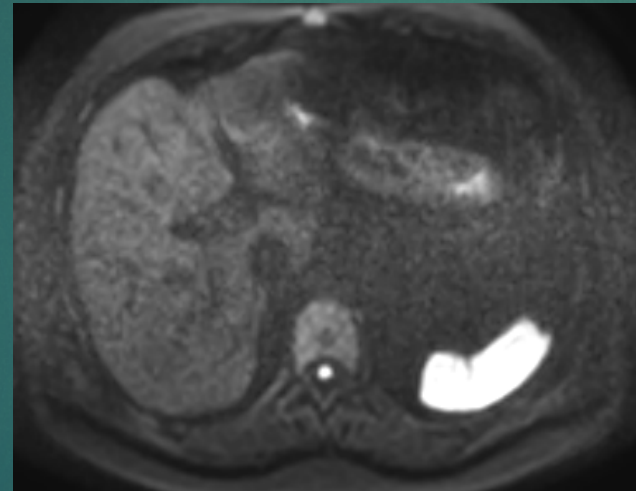
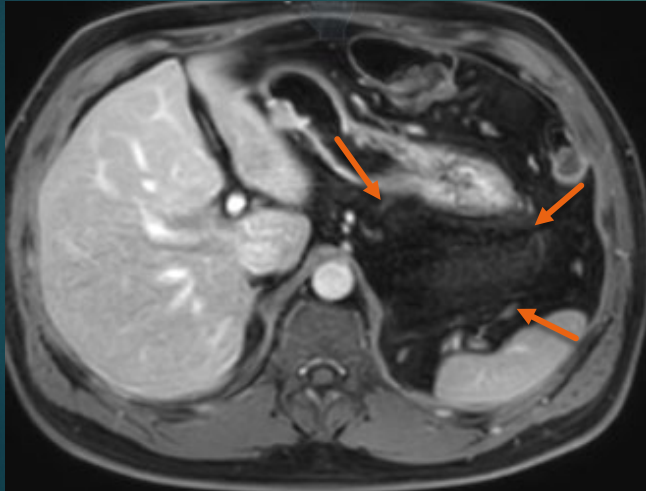
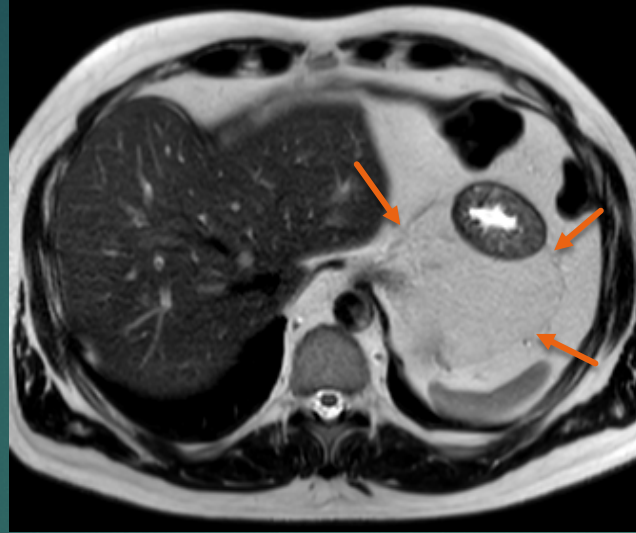
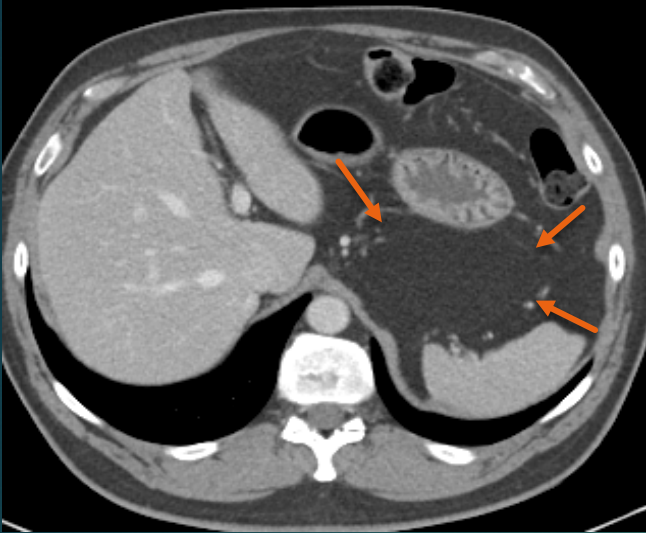
Presence of peritoneal sarcomatosis = upfront inoperability

Main differential: sarcomatoid variant of mesothelioma

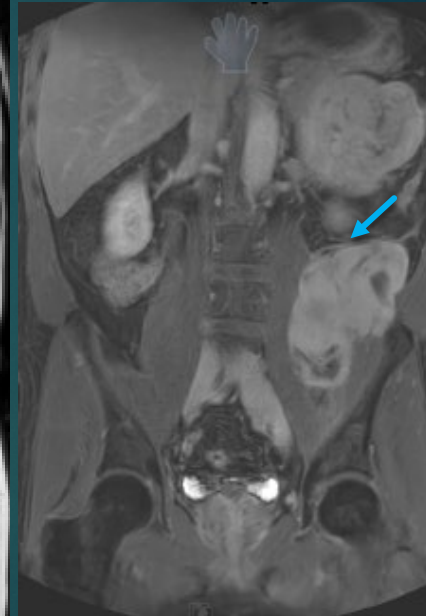
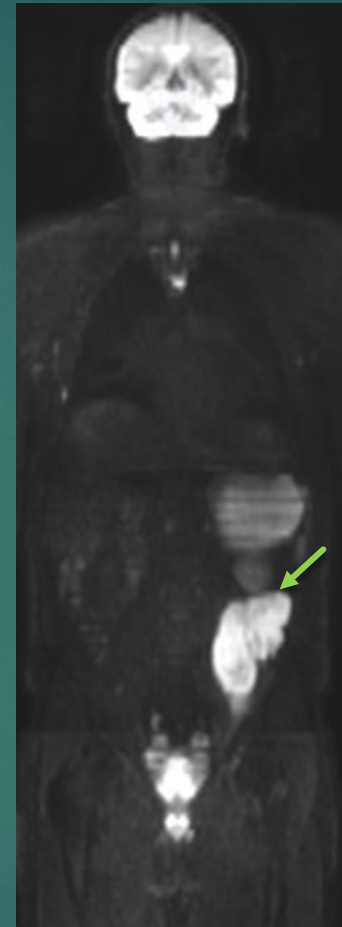


Man 67, years, GIST, staging?

Peritoneal sarcomatosis: Liposarcoma



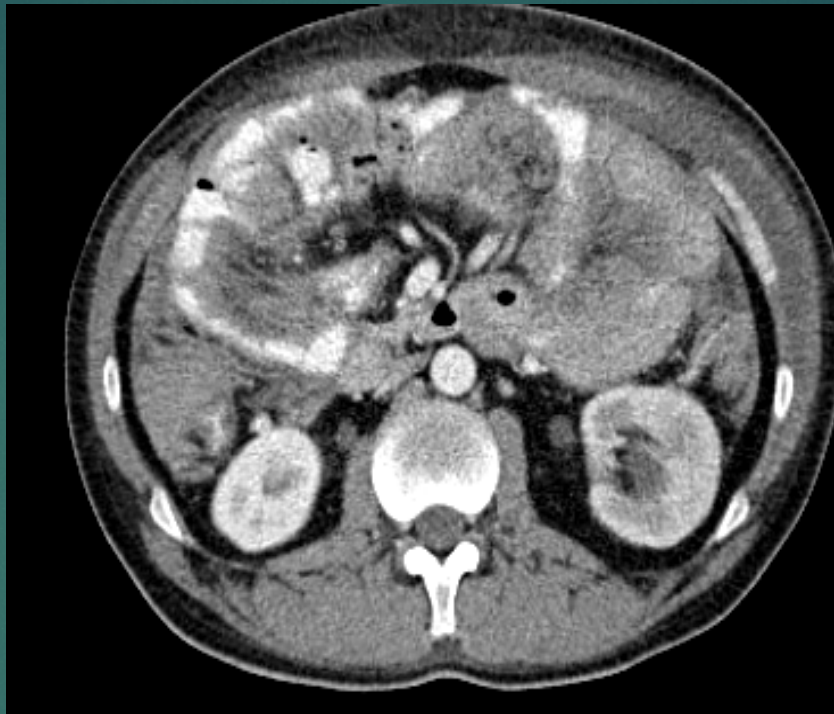
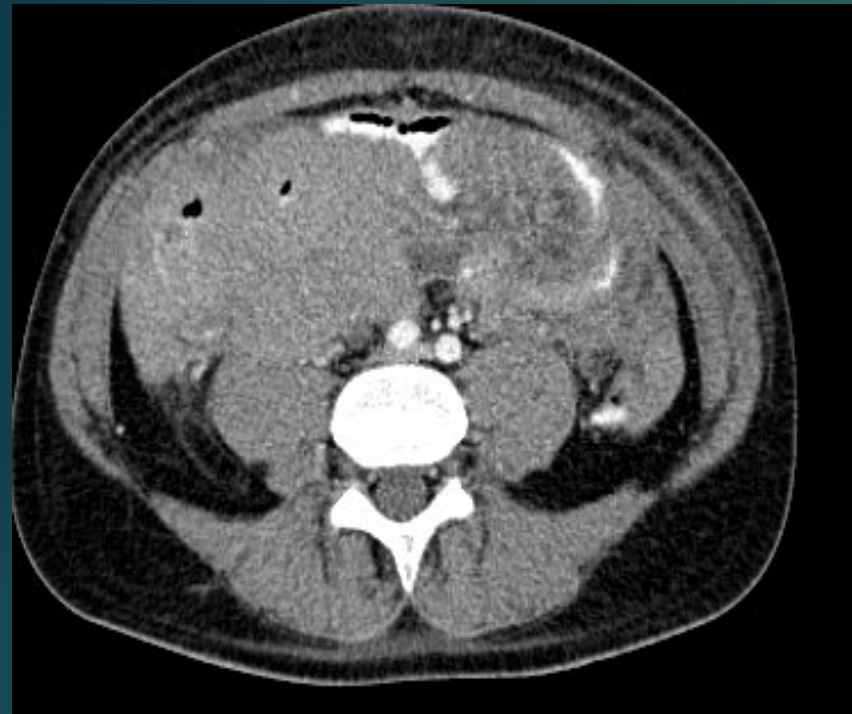
Man 52 years.
Intraperitoneal recurrence Liposarcoma
CT and MRI: Lipid content, thin walled



Man 41, years old, curative resection of
Myxoid Liposarcoma of the knee

DWI is fat-suppressed technique (detects only solid dedifferentiated part)

Radiological appearance of peritoneal metastases indicates primary?

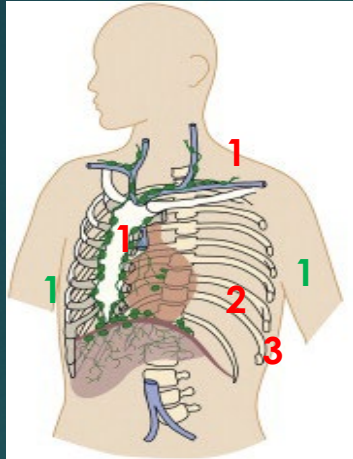


Man, 23 years, night sweats, abdominal pain, obstruction

Peritoneal lymphomatosis:
Mostly non-Hodkin large B-cell lymphoma.

Radiological peritoneal findings can be non-specific and overlap with peritoneal carcinomatosis.
Mildly enhancing bulky masses, wall thickening of long segments of small bowel loops.
Search for typical patterns of lymphadenopathies.
PET/CT imaging standard.

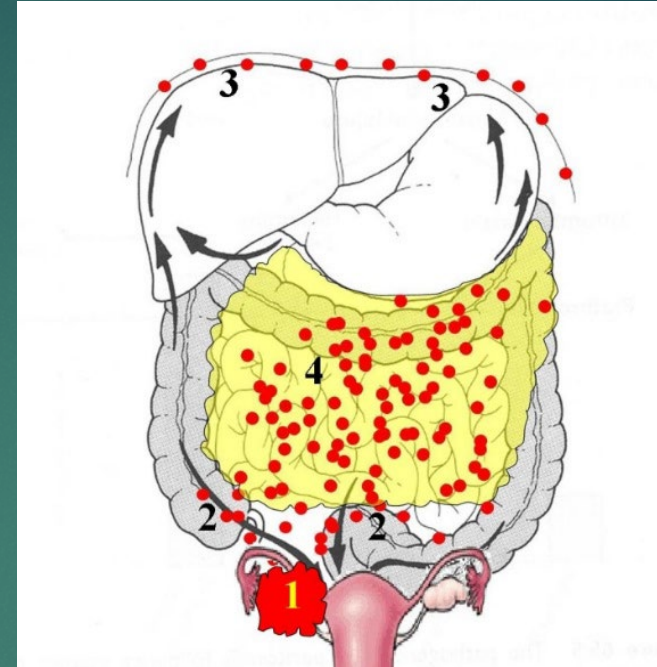
Diagnosis primary origin – operability – disease stage



2/ Distant metastases (Non-)Resectability?

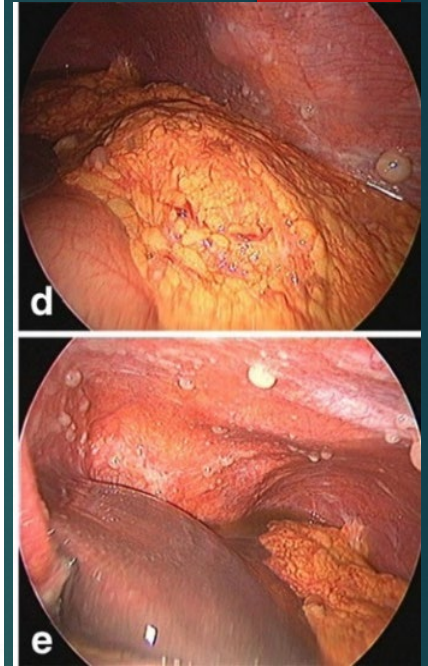
Resectability distant metastases?
and lymph nodes (1)
Pleural metastases (2)
Suprarenal lymph nodes (3)

Liver, lungs, skeletal



3/ Peritoneal metastases (Non-)Resectability?

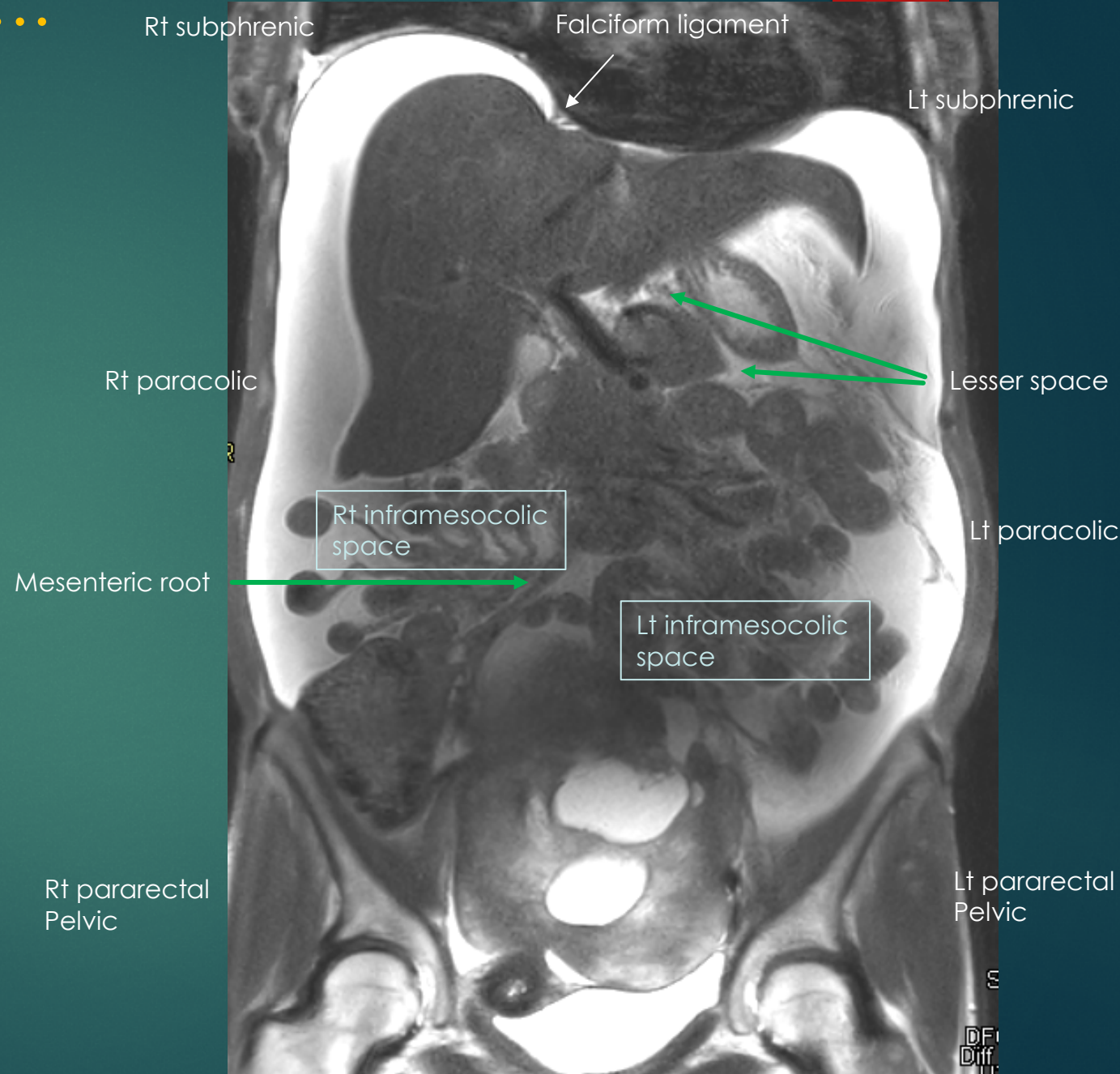
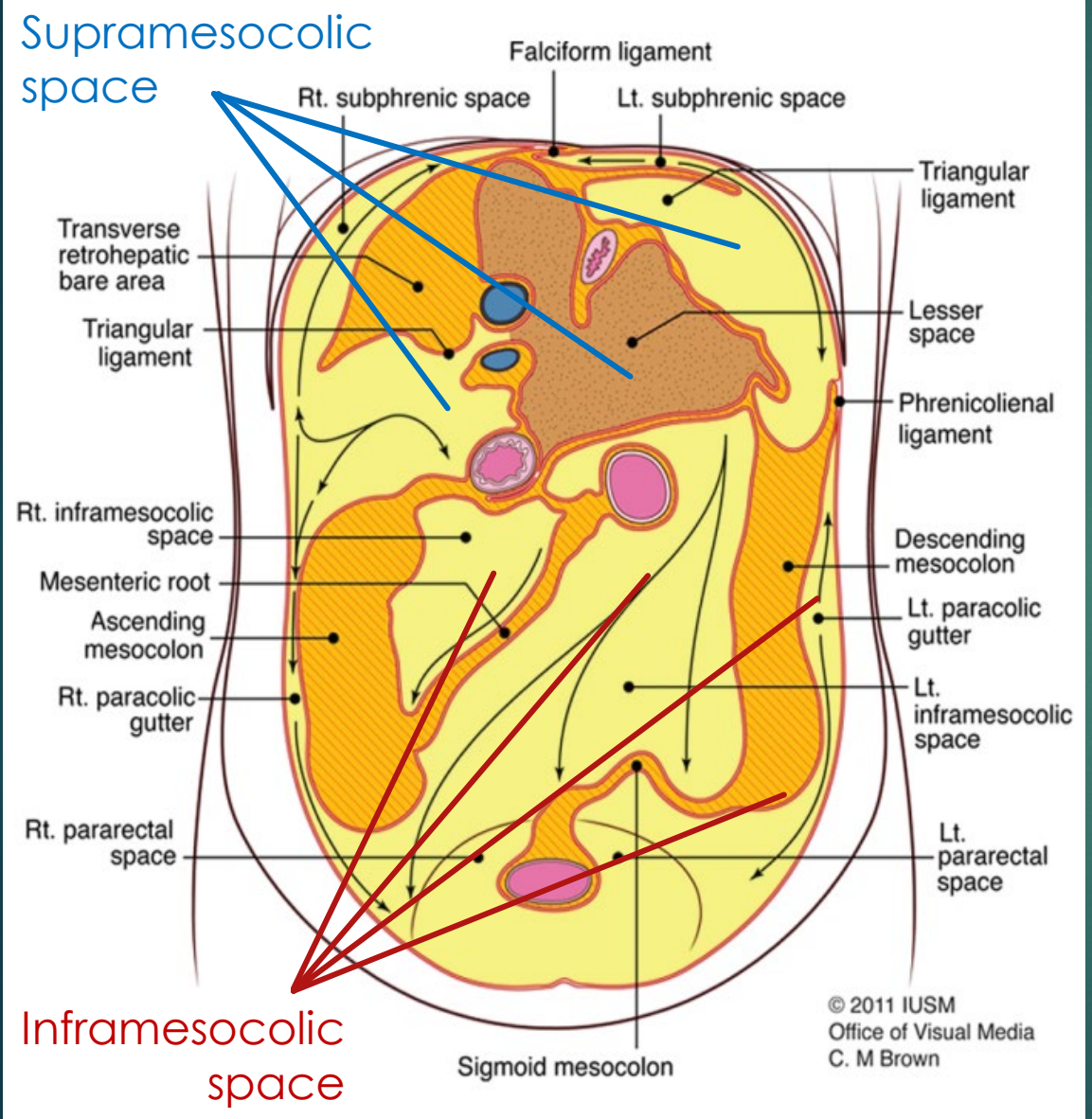
Surgically critical disease sites
Peritoneal cancer index



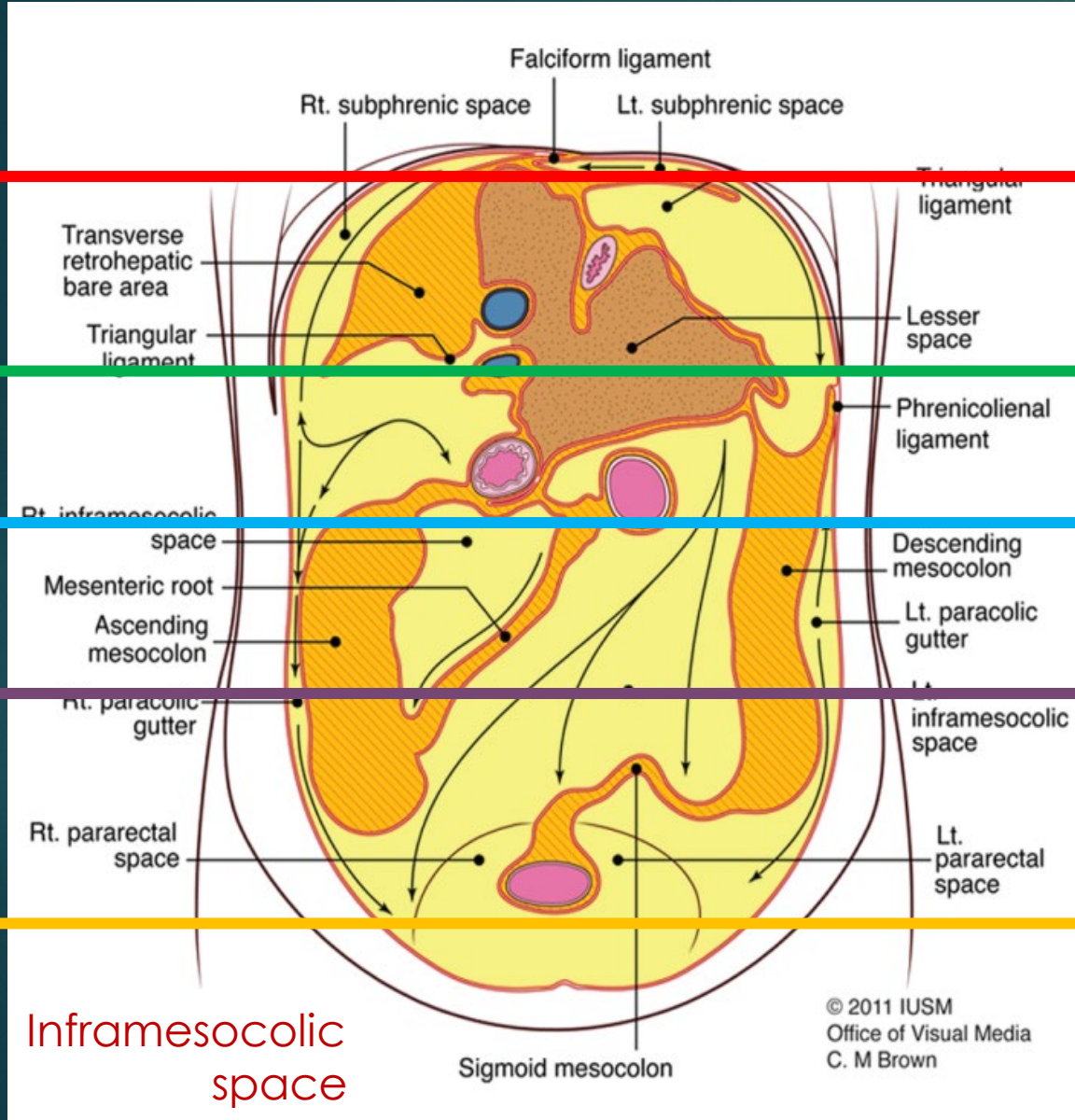
4/ Complications Hydro-ureteronefrosis Thrombosis

.....

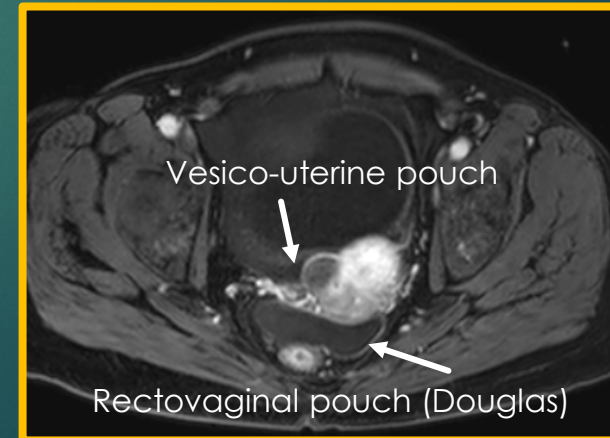
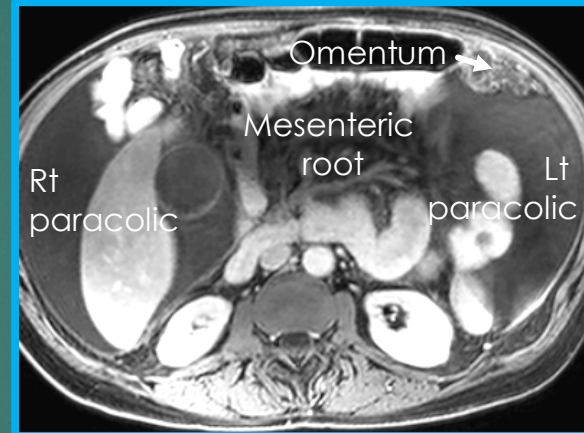
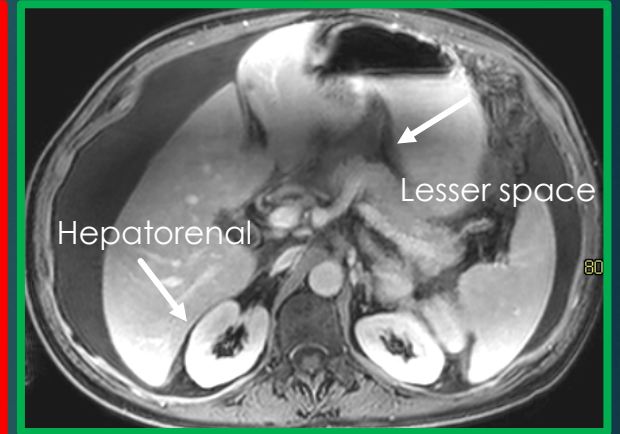
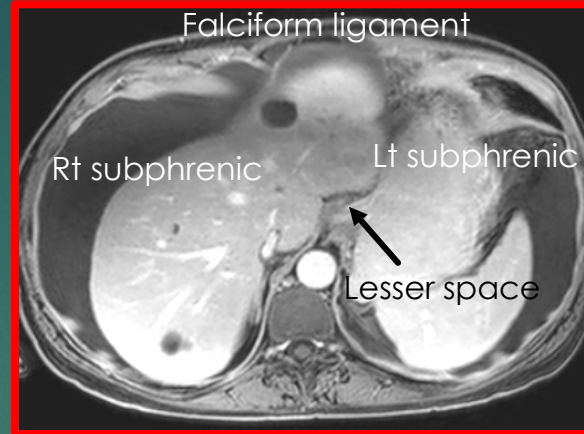
From Peritoneal anatomy....



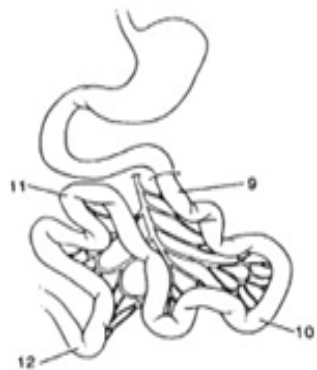
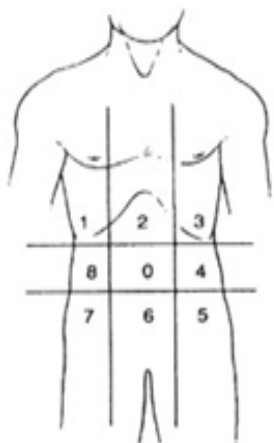
From Peritoneal anatomy...



Inframesocolic space



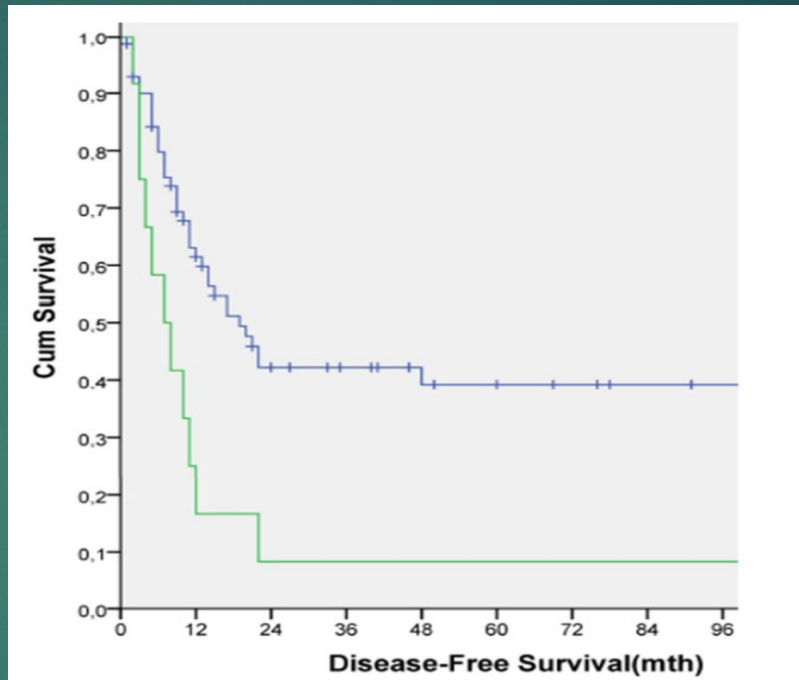
To surgically critical peritoneal anatomy.....



Regions	Lesion Size	Lesion Size Score (the largest implants scored in each regions)
0 central	_____	LS 0 No tumor seen
1 Right upper	_____	LS 1 ≤ 0.5 cm
2 Epigastrium	_____	LS 2 > 0.5 cm to ≤ 5.0 cm
3 Left upper	_____	LS 3 > 5 cm or confluence
4 Left flank	_____	
5 Left lower	_____	
6 Pelvis	_____	
7 Right lower	_____	
8 Right flank	_____	
9 Upper jejunum	_____	
10 Lower jejunum	_____	
11 Upper ileum	_____	
12 Lower ileum	_____	
PCI	0-39	

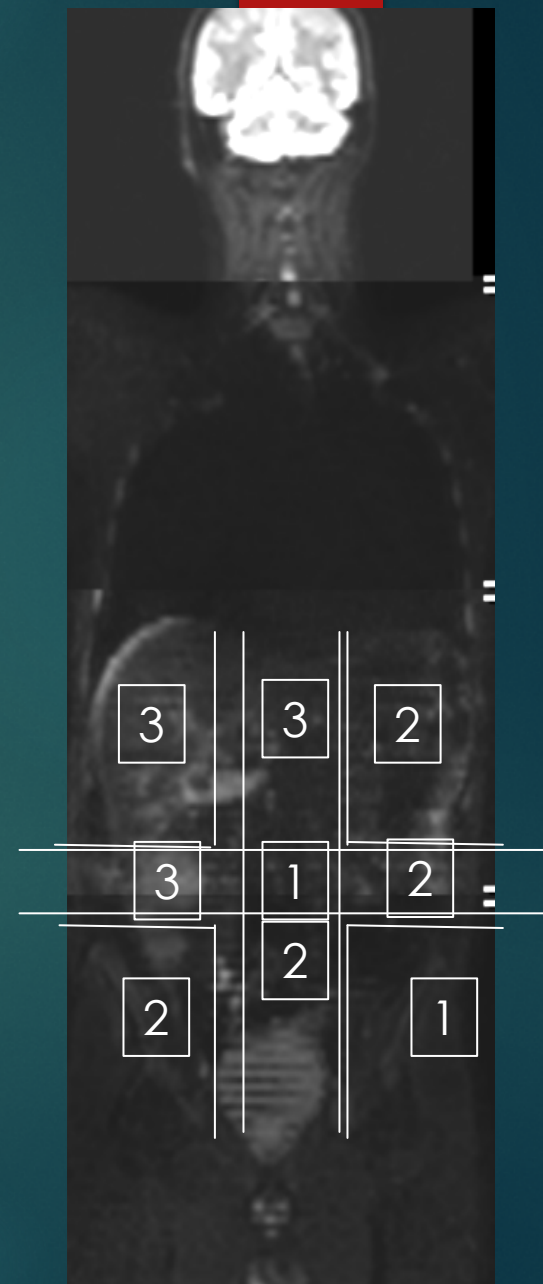
PCI: 15 threshold for HIPEC
UZ Leuven

Courtesy of A. D'Hoore and A Wolthuis



PCI > 15 threshold → survival

1 / Peritoneal Cancer Index



To surgically critical peritoneal anatomy.....

2/standardized predictive score





Espada M et al, Eur Radiol 2013

Table 1 Predictive accuracy of DWMRI for affection of anatomical sites in EL

Anatomic feature	Sensitivity	Specificity
Involvement of small and/or large bowel mesentery	100 % (8/8)	84.6 % (22/26)
Involvement of hepatic parenchyma, hepatic hylum or surface implant >2 cm	80.0 % (8/10)	83.3 % (20/24)
Involvement of spleen parenchyma, spleen hylum, stomach or lesser sac	100 % (11/11)	100 % (23/23)
Involvement of diaphragm	80.0 % (4/5)	96.6 % (28/29)
Peritoneal thickening	69.2 % (9/13)	81.0 % (17/21)
Peritoneal macroscopic implants (≥2 cm)	69.2 % (9/13)	81.0 % (17/21)
Massive ascites	50.0 % (4/8)	92.0 % (23/25)
Suprarenal para-aortic lymph nodes (≥1 cm)	100 % (5/5)	86.2 % (25/29)
Miliar visceral peritoneum implants	91.7 % (11/12)	95.5 % (21/22)
Involvement of pelvic sidewall and/or hydroureter	100 % (1/1)	93.9 % (31/33)

Table 3 Predictive parameters upon the score threshold selected

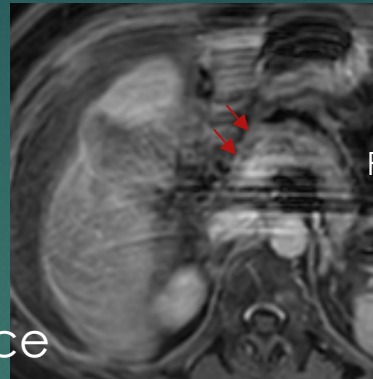
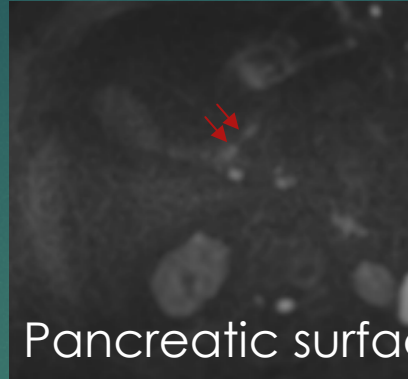
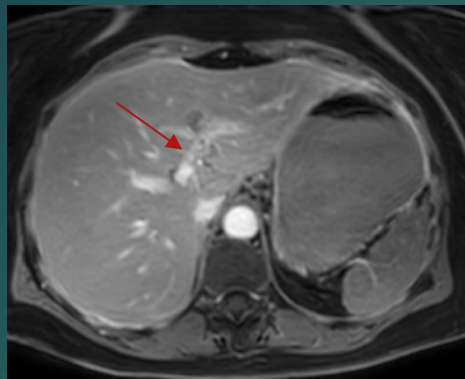
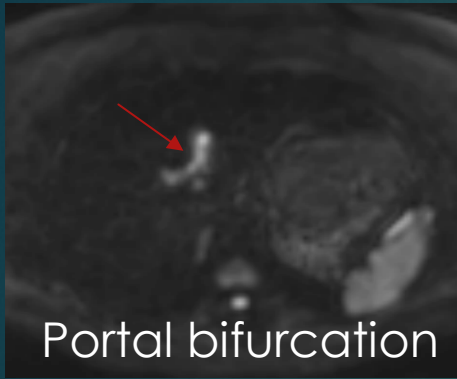
Total score points	Sensitivity	Specificity	PPV	NPV	Accuracy	Unnecessarily explored (%) ^a	Inappropriately unexplored (%) ^b
DWMRI							
≥1	100 % (8/8)	34.6 % (9/26)	32.0 % (8/25)	100 % (9/9)	50 % (17/34)	0 %	65.4 % (17/26)
≥2	100 % (8/8)	61.5 % (16/26)	44.4 % (8/18)	100 % (16/16)	70.5 % (24/34)	0 %	38.5 % (10/26)
≥3	100 % (8/8)	69.2 % (18/26)	50.0 % (8/16)	100 % (18/18)	76.4 % (26/34)	0 %	30.8 % (8/26)
≥4	87.5 % (7/8)	80.8 % (21/26)	58.3 % (7/12)	95.5 % (21/22)	82.3 % (28/34)	12.5 % (1/8)	19.2 % (5/26)
≥5	75.0 % (6/8)	92.3 % (24/26)	75.0 % (6/8)	92.3 % (24/26)	88.2 % (30/34)	25.0 % (2/8)	7.7 % (2/26)
≥6	75.0 % (6/8)	96.2 % (25/26)	85.7 % (6/7)	92.6 % (25/27)	91.1 % (31/34)	25.0 % (2/8)	3.8 % (1/26)
≥7	62.5 % (5/8)	96.2 % (25/26)	83.3 % (5/6)	89.3 % (25/28)	88.2 % (30/34)	37.5 % (3/8)	3.8 % (1/26)
≥8	12.5 % (1/8)	100 % (26/26)	100 % (1/1)	78.8 % (26/33)	79.4 % (27/34)	87.5 % (7/8)	0 % (0/26)

Essen criteria	Leuven criteria
Biopsy with histologically proven epithelial ovarian (or tubal or peritoneal) cancer FIGO stage IIIC-IV	
-	Or fine needle aspiration proving the presence of carcinoma cells in patients with a suspicious pelvic mass if CA125 (KU/L)/CEA (ng/mL) ratio is > 25. If the serum CA125/CEA ratio is ≤ 25, imaging or endoscopy is obligatory to exclude a primary gastric, colon or breast carcinoma
Involvement of the superior mesenteric artery	
Diffuse deep infiltration of the radix mesenterii of the small bowel	
Diffuse and confluent carcinomatosis of the stomach and/or small bowel involving such large parts that resection would lead to a short bowel syndrome or a total gastrectomy	
Multiple parenchymatous liver metastases in both lobes	Intrahepatic metastases
Tumor involving large parts of the pancreas (not only tail) and/or the duodenum	Infiltration of the duodenum and/or pancreas and/or the large vessels of the ligamentum hepatoduodenale, truncus coeliacus or behind the porta hepatis
Tumor infiltrating the vessels of the lig. Hepatoduodenale or truncus coeliacus	
Not completely resectable metastases, as eg. - Multiple parenchymal lung metastases (preferably histologically proven) - Non resectable lymphnode metastases - Brain metastases	All excluding: - Resectable inguinal lymph nodes - Solitary resectable retrocrural or paracardial nodes - Pleural fluid containing cytologically malignant cells without proof of the presence of pleural tumors

Vergote I, et al. *Gynecol Oncol.* 2013;128(1):6-11.

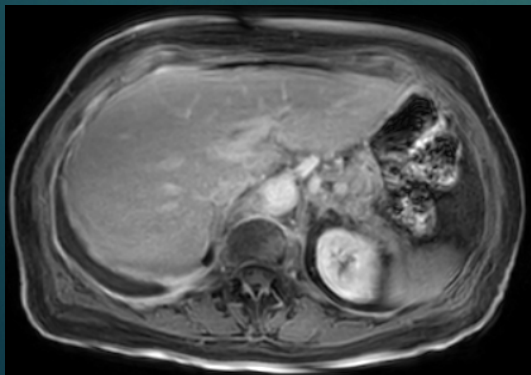
3/ Site based predictive score

3/ Peritoneal metastases: (Non-)Resectability?



** Upper abdomen

■ WB-DWI-MRI
■ CT



WB-DWI/MRI	15	1	77	1	93.8 [71.7-98.9]	98.7 [93.1-99.8]	93.8 [71.7-98.9]	98.7 [93.1-99.8]	97.9 [92.6-99.4]
CT	11	1	77	5	68.8 [44.4-85.8]	98.7 [93.1-99.8]	91.7 [64.6-98.5]	93.9 [86.5-97.4]	93.6 [86.8-97.0]

Michielsen K et al, EJC 2017

Lymph nodes along the hepatic hilum	58	4	7	47	0	87.9 (76.7-95.0)
	58	1	6	48	3	84.5 (72.6-92.7)
Carcinomatosis along the round hepatic ligament	55	10	8	31	6	74.5 (61.0-85.3)
	55	3	3	36	13	70.9 (57.1-82.4)

Rizzo S et al, Eur J Radiol 2020

Involvement of hepatic parenchyma, hepatic hylum or surface implant >2 cm	80.0 % (8/10)	83.3 % (20/24)	66.6 % (8/12)	90.9 % (20/22)
---	---------------	----------------	---------------	----------------

Espada M et al, Eur Radiol 2013

Rizzo S et al, Eur J Radiol 2020

Pericardiophrenic lymph nodes	28	10	1	15	2	89.3 (71.8-97.7)	0.01
	28	6	3	13	6	67.9 (47.6-84.1)	

3/ Peritoneal metastases: (Non-)Resectability?

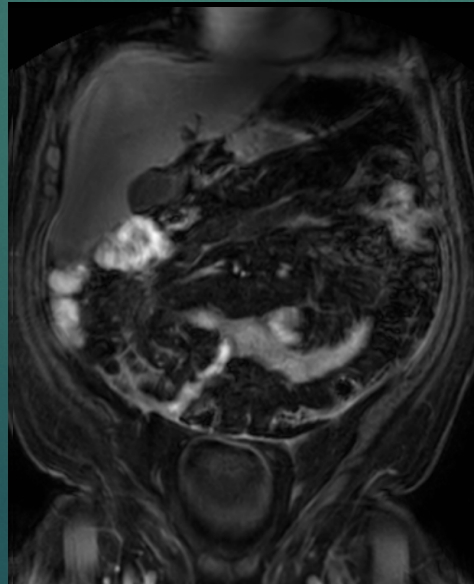
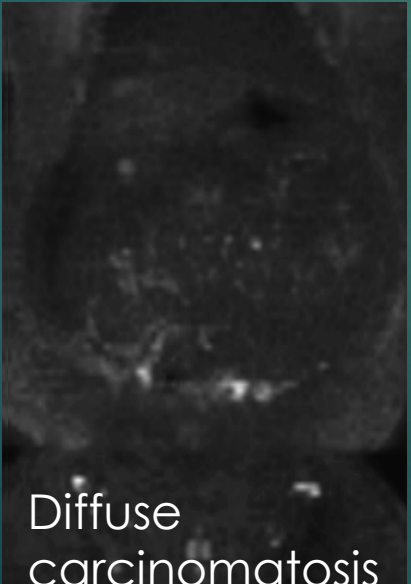
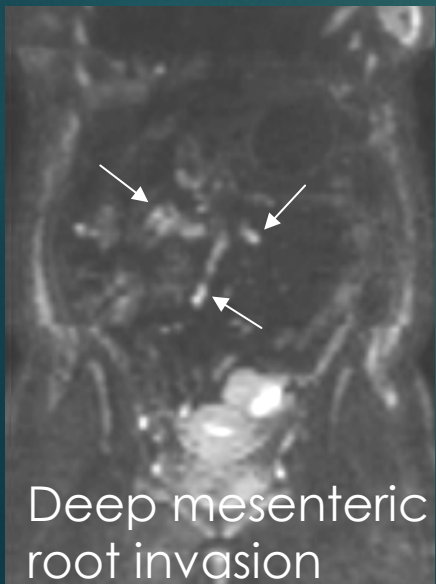
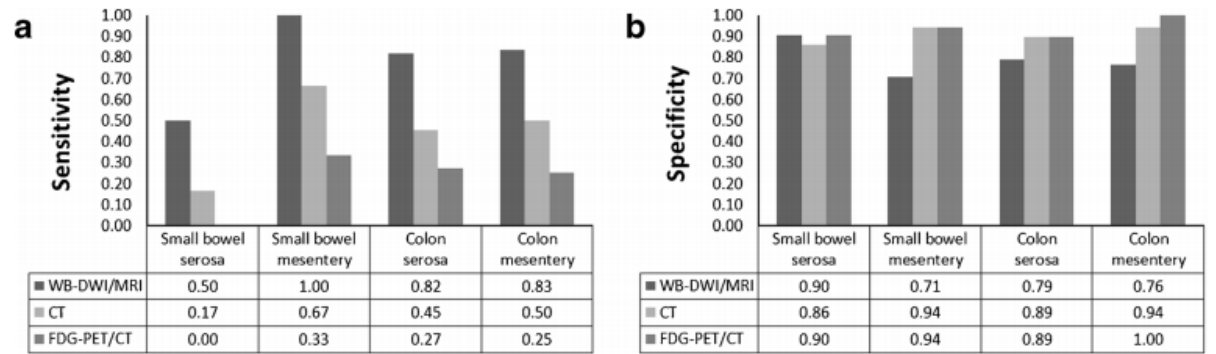
Eur Radiol (2014) 24:889-901
DOI 10.1007/s00330-013-3083-8

UROGENITAL

Whole-body MRI with diffusion-weighted sequence for staging of patients with suspected ovarian cancer: a clinical feasibility study in comparison to CT and FDG-PET/CT

Katrijn Michielsens · Ignace Vergote · Katya Op de beeck · Frederic Amant · Karin Leunen · Philippe Moerman · Christophe Deroose · Geert Souverijns · Steven Dymarkowski · Frederik De Keyzer · Vincent Vandecaveye

Intestinal deposits



European Journal of Radiology 123 (2020) 108786

Contents lists available at ScienceDirect

European Journal of Radiology

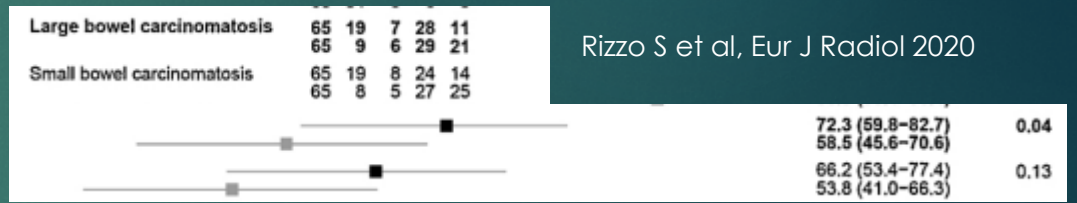
journal homepage: www.elsevier.com/locate/ejrad

Research article

Pre-operative evaluation of epithelial ovarian cancer patients: Role of whole body diffusion weighted imaging MR and CT scans in the selection of patients suitable for primary debulking surgery. A single-centre study

Stefania Rizzo^{a,b}, Francesca De Piano^a, Valentina Buscarino^a, Eleonora Pagan^a, Vincenzo Bagnardi^a, Vanna Zanagnolo^a, Nicoletta Colombo^{a,c}, Angelo Maggioni^a, Maria Del Grande^a, Filippo Del Grande^a, Massimo Bellomi^{b,d}, Giovanni Aleotti^{a,b}

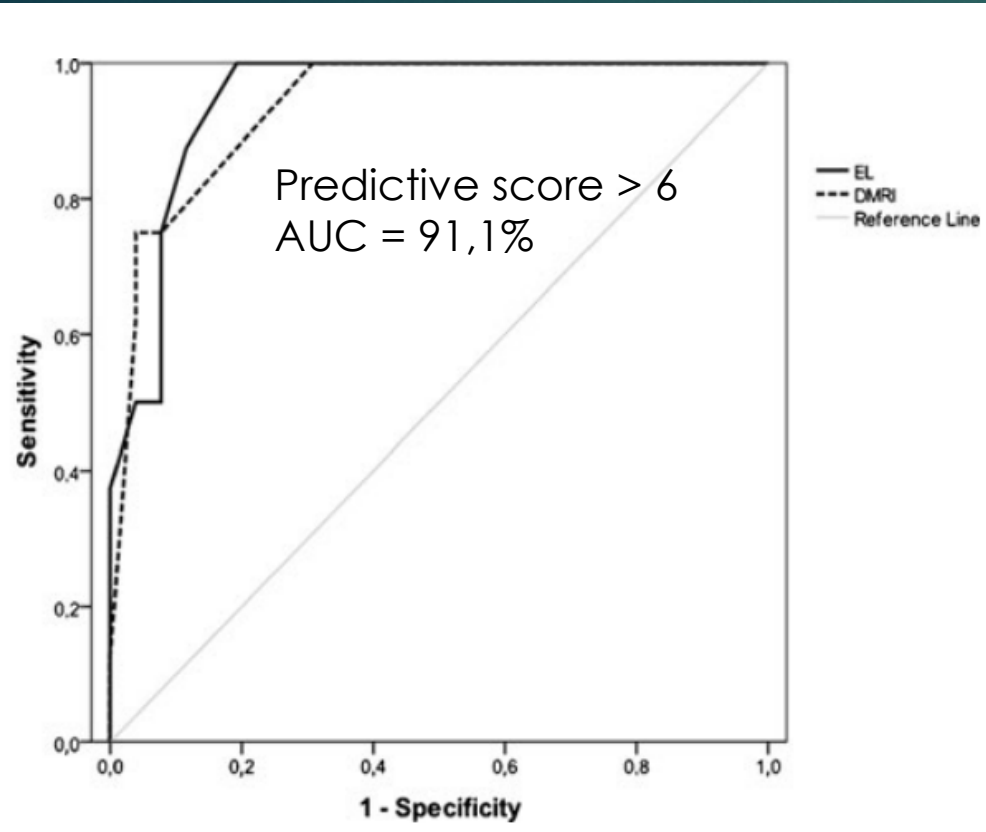
	WB-DWI-MRI	CT	FDG-PET/CT	Accuracy % (95% CI)	P-value
Large bowel carcinomatosis	65 19 7 28 11	65 9 6 29 21		72.3 (59.8-82.7)	0.04
Small bowel carcinomatosis	65 19 8 24 14	65 8 5 27 25		66.2 (53.4-77.4)	0.13
Carcinomatosis on the sigmoid rectum	63 49 7 4 3	63 44 8 3 8		84.1 (72.7-92.1)	0.03
Mesenteric carcinomatosis	65 26 7 21 11	65 19 13 15 18		72.3 (59.8-82.7)	0.02



Bowel serosal and mesenteric involvement	Specificity	Sensitivity	Accuracy
Our study			
US	0.94 (0.81-0.99)	0.42 (0.25-0.61)	0.70 (0.58-0.81)
WB-DWI/MRI	0.89 (0.74-0.97)	0.65 (0.45-0.81)	0.78 (0.66-0.87)
CT	0.92 (0.78-0.98)	0.65 (0.45-0.81)	0.79 (0.67-0.88)

Fischerova D et al, Ultrasound Obstet Gynecol. 2022

Predicting R0 surgery in primary diagnosis of ovarian cancer: MRI >>>>CT



Espada M et al, Eur Radiol 2013

standardized predictive score

Table 4
Comparative accuracy for predicting incomplete resection.

Diagnostic accuracy	WB-DWI	CT
TP	47	33
FP	1	10
TN	43	34
FN	3	17
Sensitivity ^a	94.0 (84–98)	66.0 (52–78)
Specificity ^a	97.7 (88–100)	77.3 (63–87)
Positive predictive value ^a	97.9 (89–100)	76.7 (62–87)
Negative predictive value ^a	93.5 (83–98)	66.7 (53–78)
Accuracy ^a	95.7 (90–98)	71.3 (61–79)

WB-DWI, whole body diffusion-weighted imaging; CT, computed tomography; TP, true positive; FP, false positive; TN, true negative; FN, false negative.

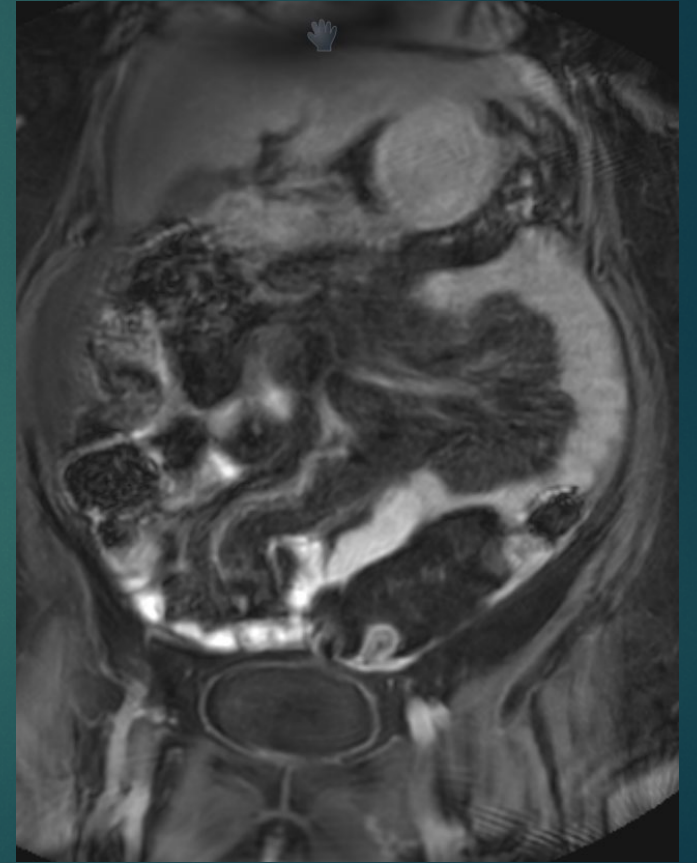
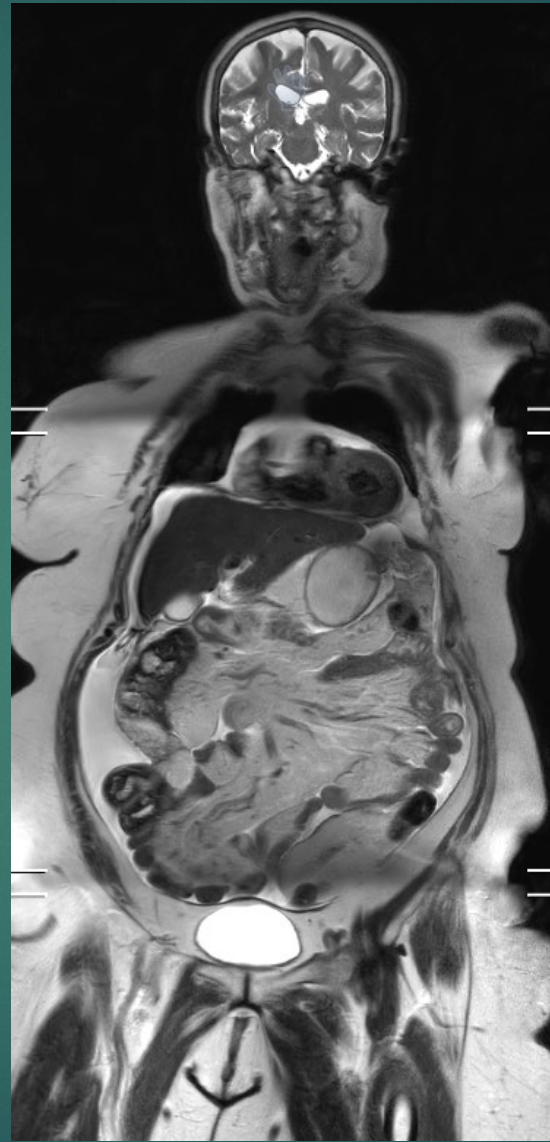
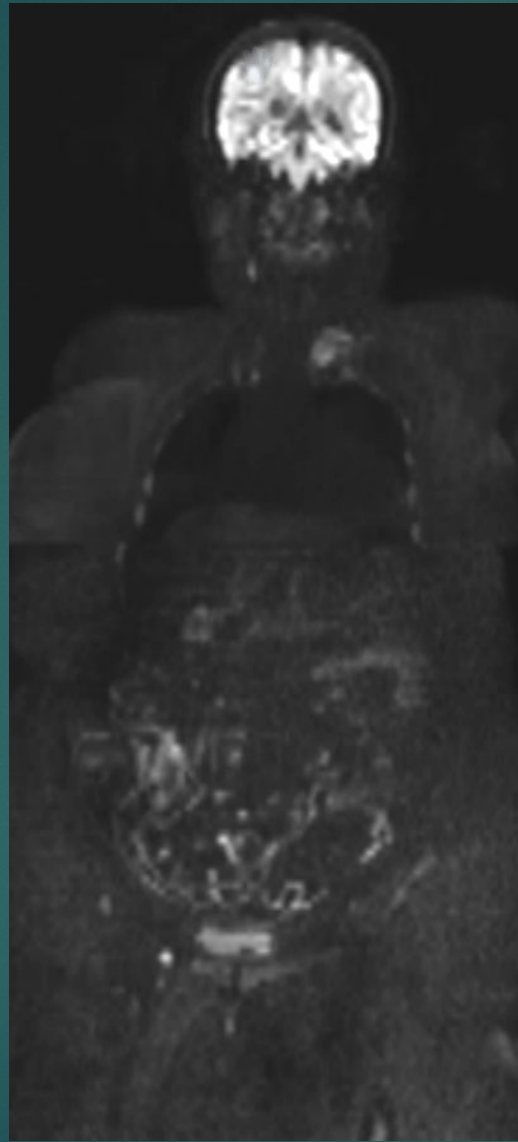
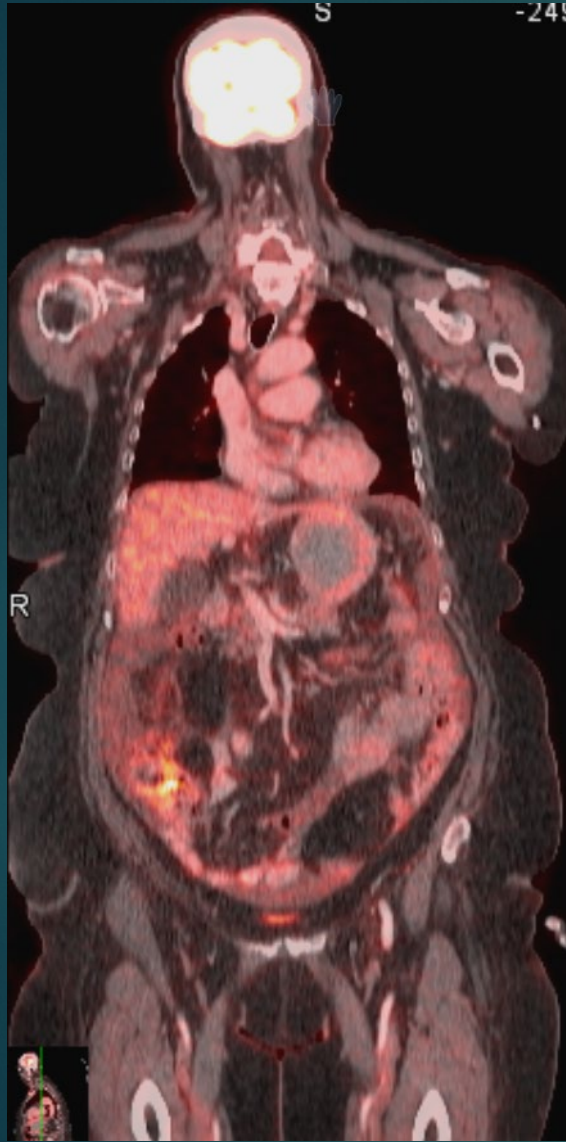
^a Numbers indicate percentages (95% confidence interval based on Wilcon Score).

Michielsen K et al, EJC 2017

Site based interpretation

Prediction of (in)complete resection → operability assessment

WB-DWI/MRI in primary ovarian cancer staging and operability assessment



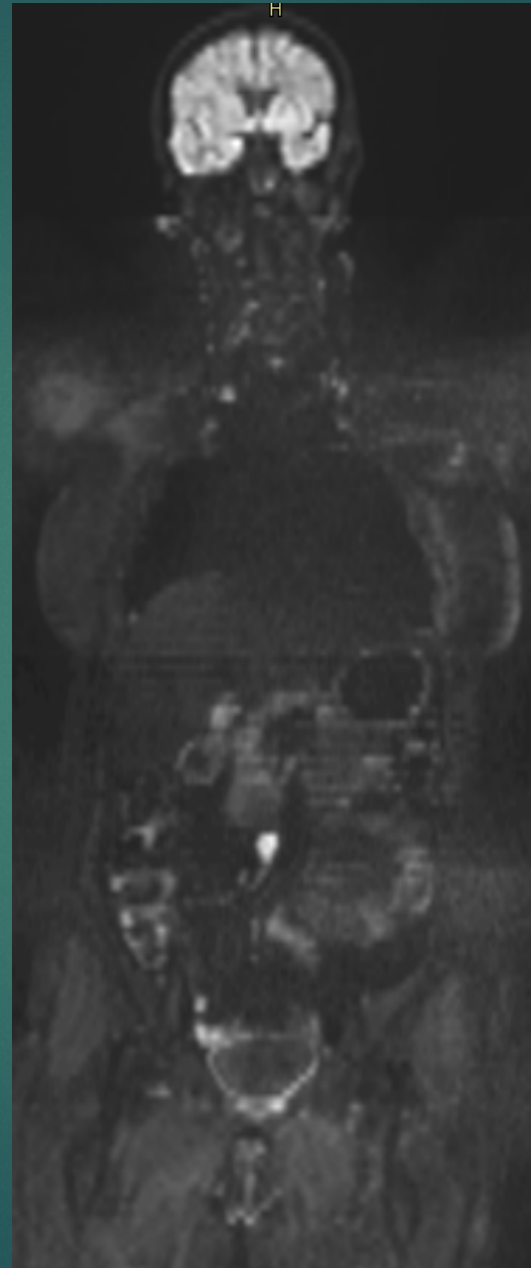
New diagnosis of ovarian cancer: PET/CT limited disease load – WB-DWI/MRI diffuse invasive miliary M+ (IIIC)

WB-DWI/MRI in primary ovarian cancer staging and operability assessment



CT-scan:
Retroperitoneal adenopathy

→ MRI peritoneal staging prior
to secondary debulking surgery



MRI - Diseases of the peritoneum – take home messages

* Metastatic peritoneal tumours most common – consider also primary diseases

* MRI sequence protocol is basic but should cover large volume:

- STIR-DWI > SPAIR DWI for whole body or full abdomen MRI
- T2, DWI (b50-1000) and 3-5 minutes delayed contrast-MRI (Transverse and coronal)

* MRI protocol takes 38 minutes or less, more complicated interpretation, high precision in small lesion detection:
→ Operability assessment

MRI anatomy should match surgical anatomy to standardize communication with referring clinician

** Surgically critical tumour sites

** Peritoneal Cancer Index