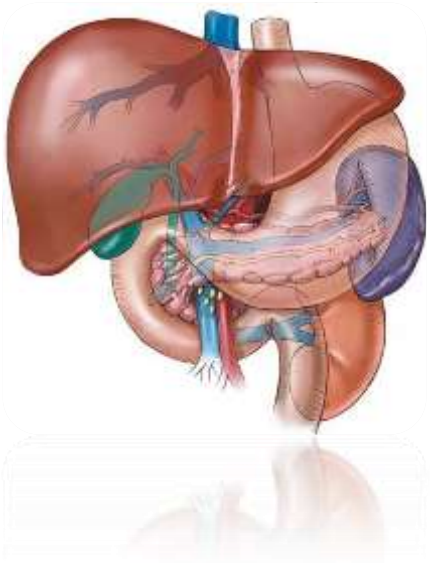


# Peritoneální karcinomatóza

T. Andrašina

Dept. of Radiology, University Hospital Brno
and Medical Faculty Masaryk University Brno, Czech Republic

# Peritoneální karcinomatóza

- Etiologie
- Distribuce
- Staging
- Terapeutické možnosti

# Peritoneum

- **Karcinomatóza peritonea –** intraperitoneální diseminace tumoru, který nemá origo na peritoneu.

- **Hematogenně - G3 malignity**
- **Lymfogenně – velké omentum, subfrenický lymf. systém**
- **Přímý přestup přes serózu – lokoregionální postižení**

- **Šíření po povrchu – gravitace,peristaltika**
- **Peroperační ruptura a diseminace**

- **Ascites**

- obstrukce lymfatického systému
- zvýšená produkce peritoneální tekutiny

FNBRNO

# Etiologie

- Ovariální neoplazie
- Karcinomy žaludku
- Karcinomy kolorekta
- Karcinomy pankreatu

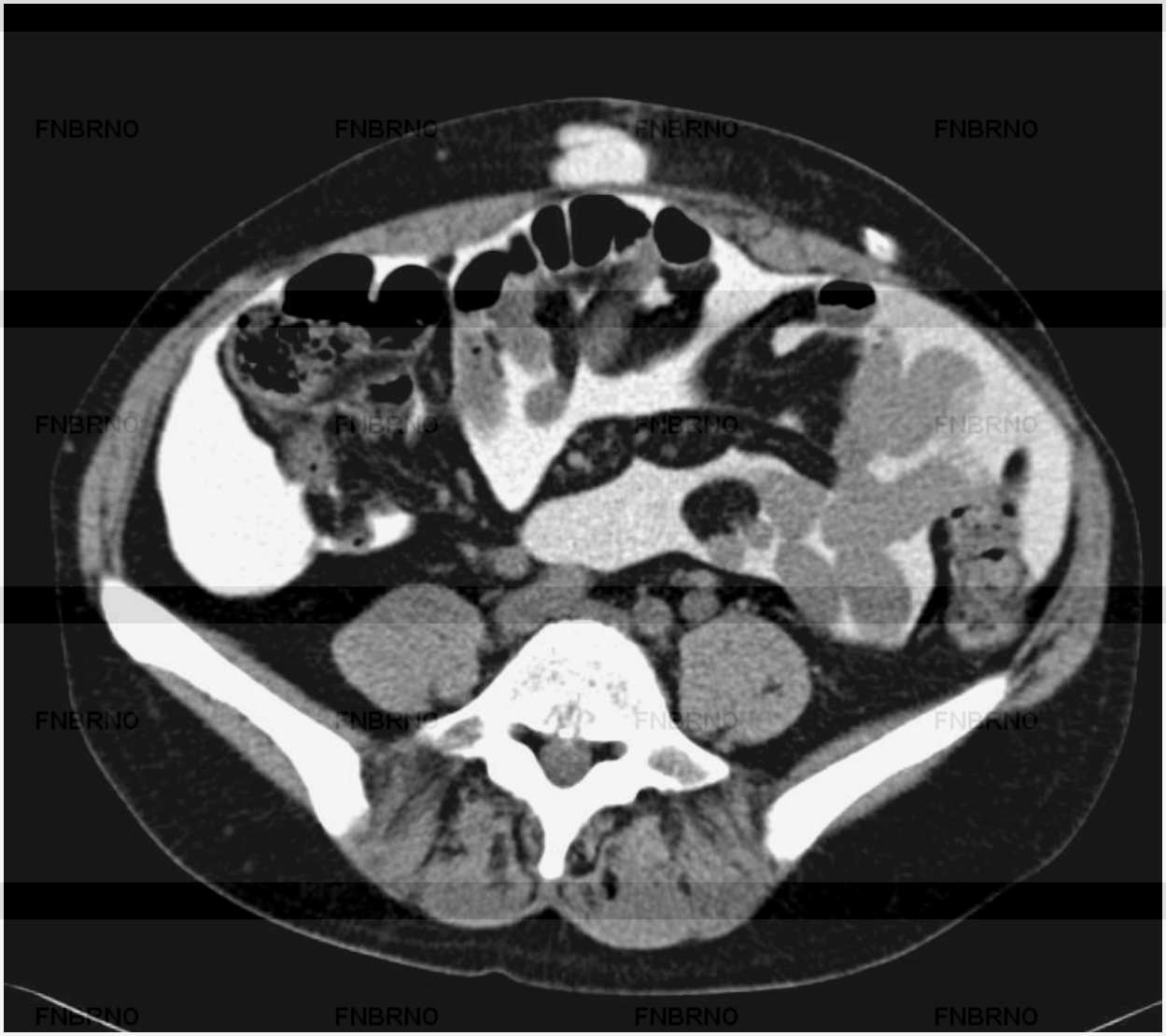
- Méně časte – metastatické plicní tumory, ca prsu, renální karcinom
- Vzácné sarkomy, lymfomy

# TNM klasifikace

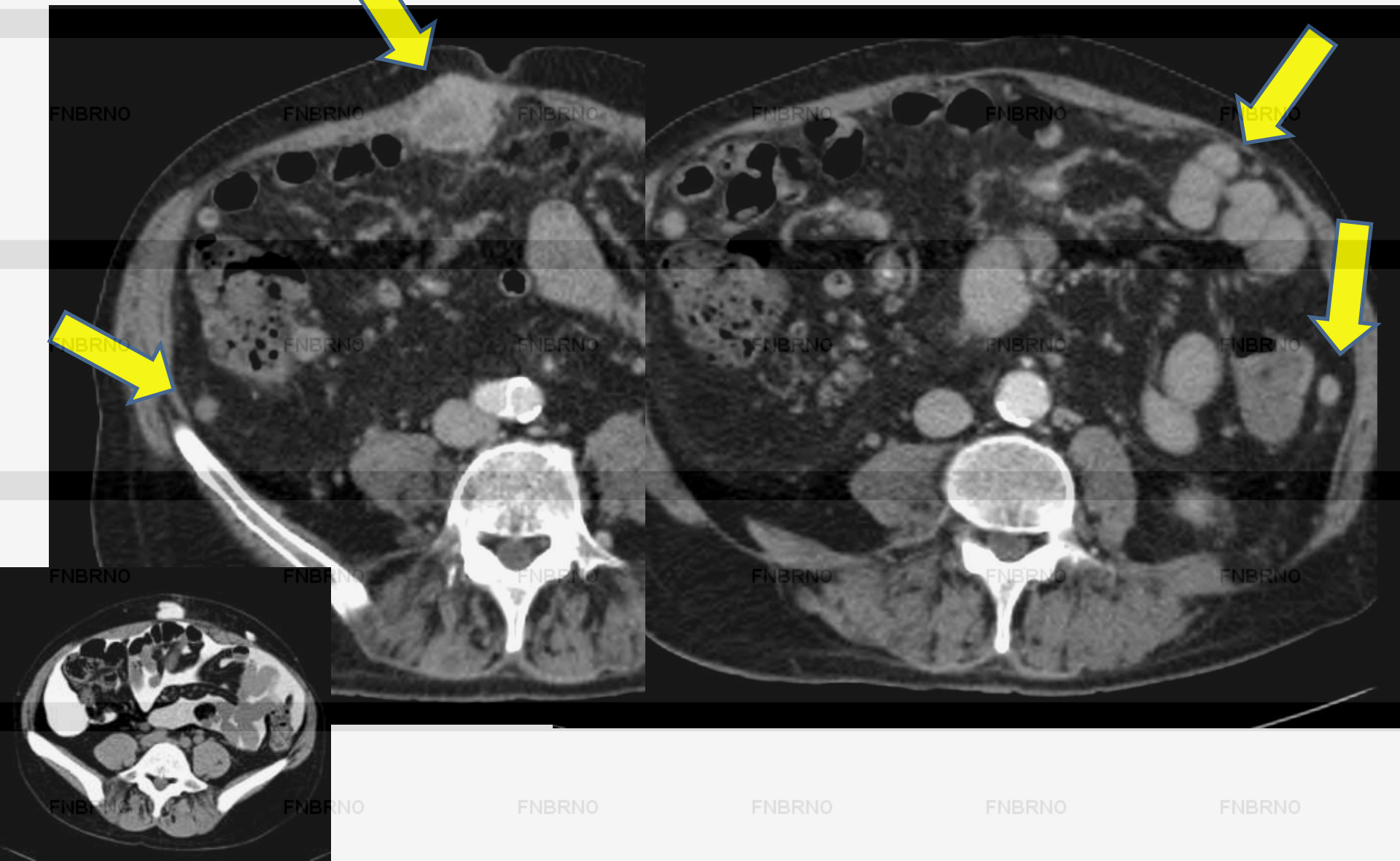
- Karcinom žaludku M1 st. IV
- Karcinom kolorekta M1b st. IVB
- Karcinom pankreatu M1 st. IV.
- Karcinom apendixu
  - T4a pravý dolní kvadrant st. IIb
  - M1a mimo pravý dolní kvadrant mucinózní G1 – st. IVA, G2,3- St.IVB (M1b mimo peritoneum, st. IVC)
- Neoplazie vaječníku
  - T1c (omezen na vaječník + bunky v ascitu) st. IC
  - T2c (šíření v pánvi) st. IIC
  - T3a mikroskopické perit. meta mimo pánev st. IIIA
  - T3b 2cm a méně mimo pánev st. IIIB
  - T3c nad 2cm mimo pánev st. IIIC

FNBRNO

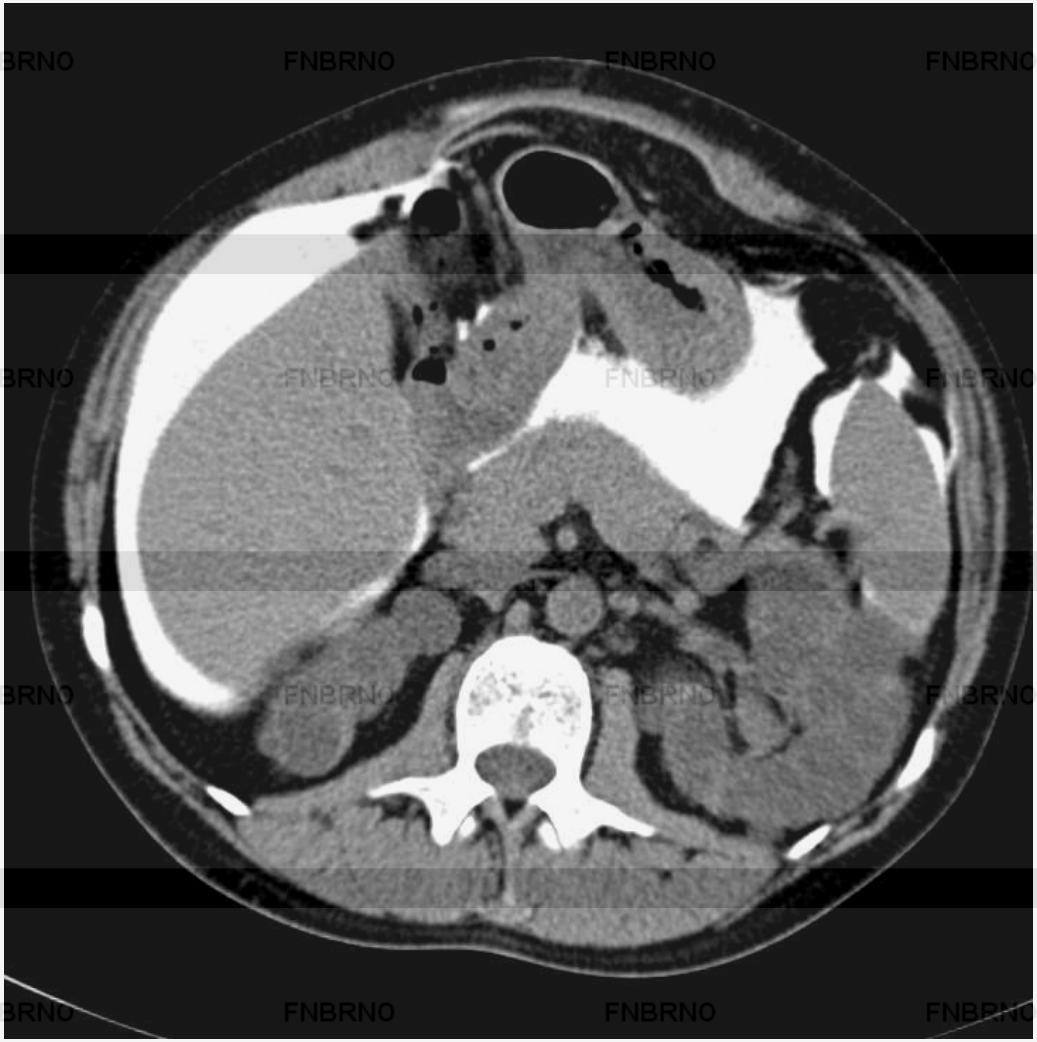
# Distribuce



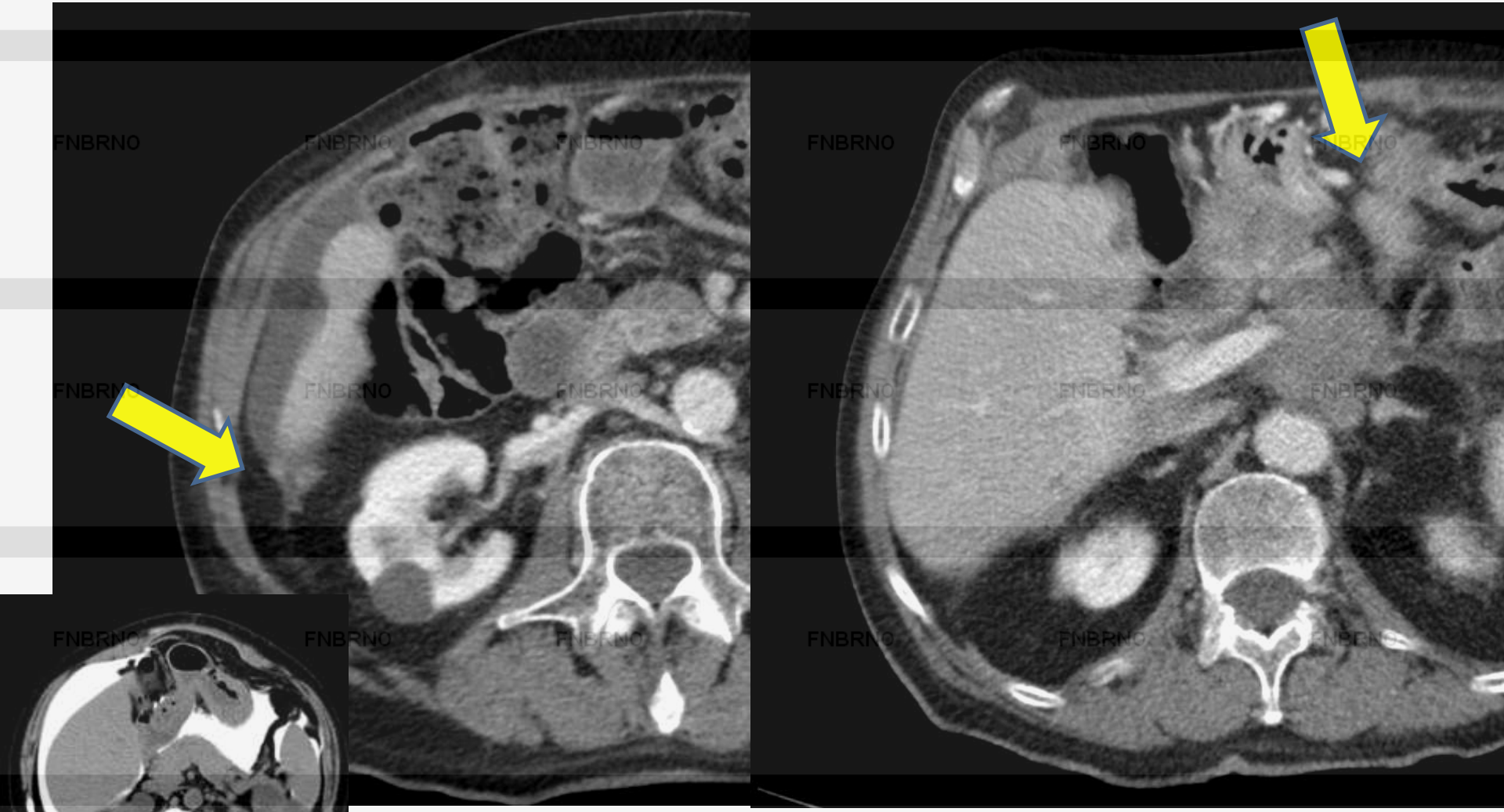
# Ca plic

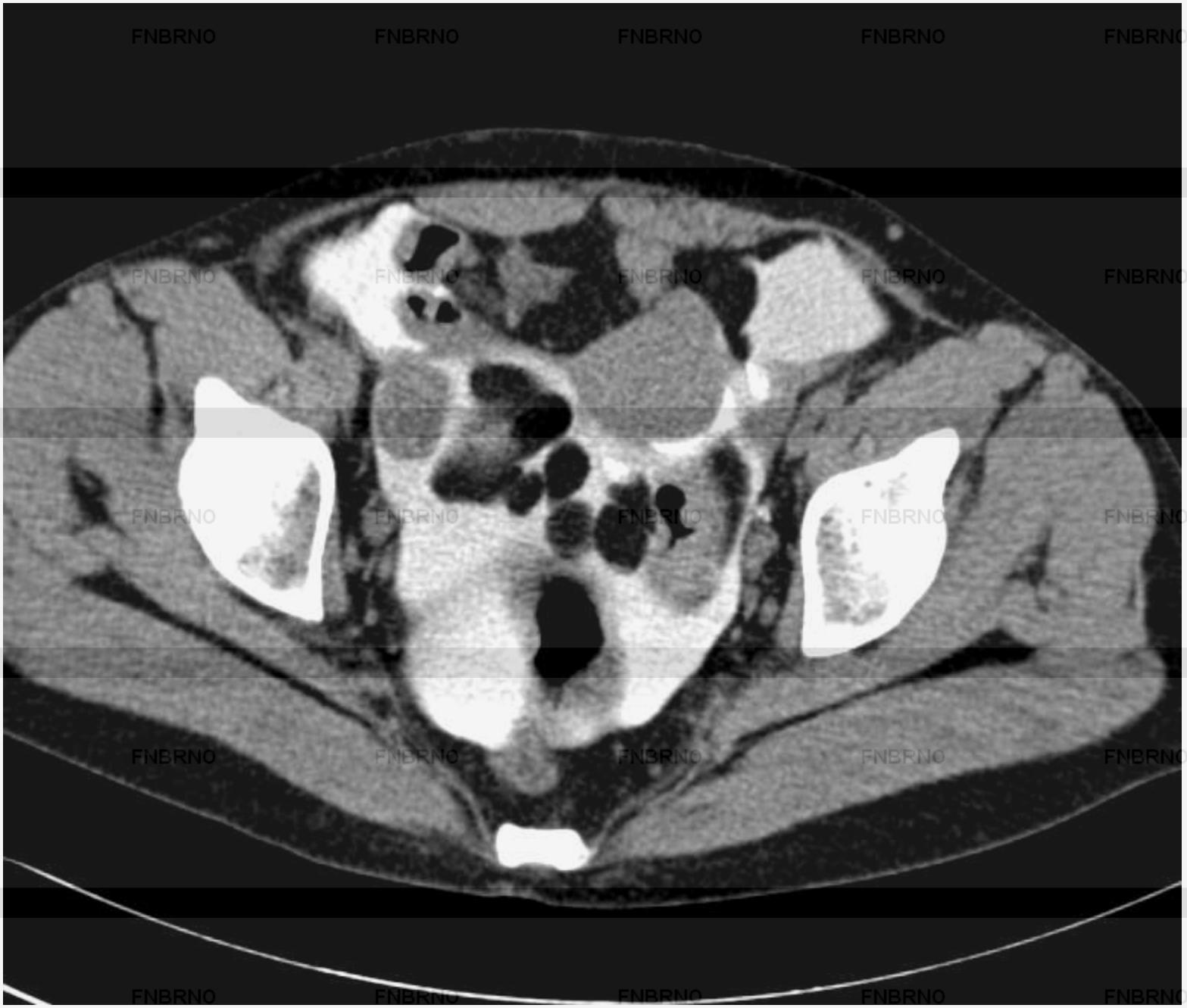


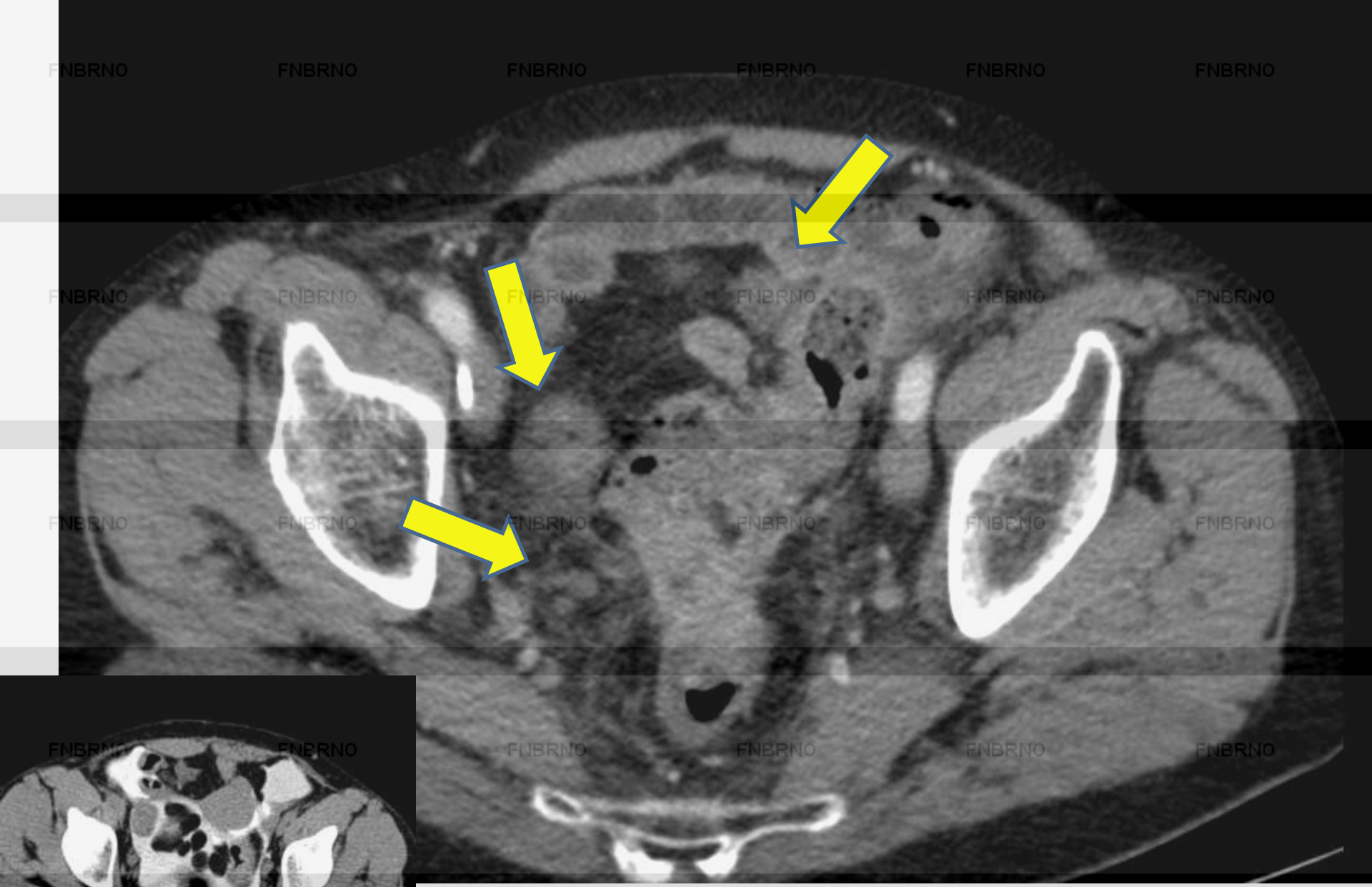
# Distribuce

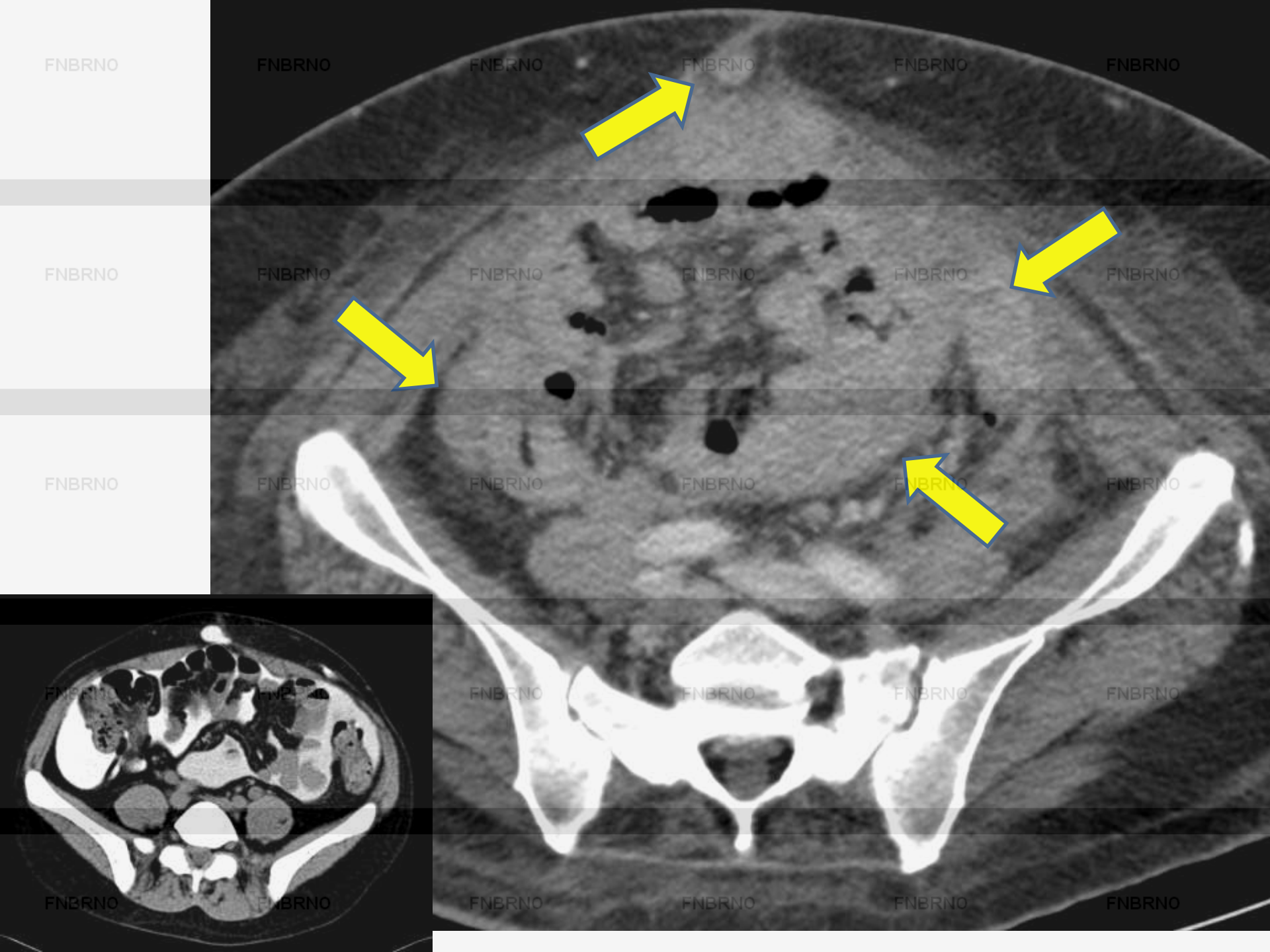


# Ca pankreatu

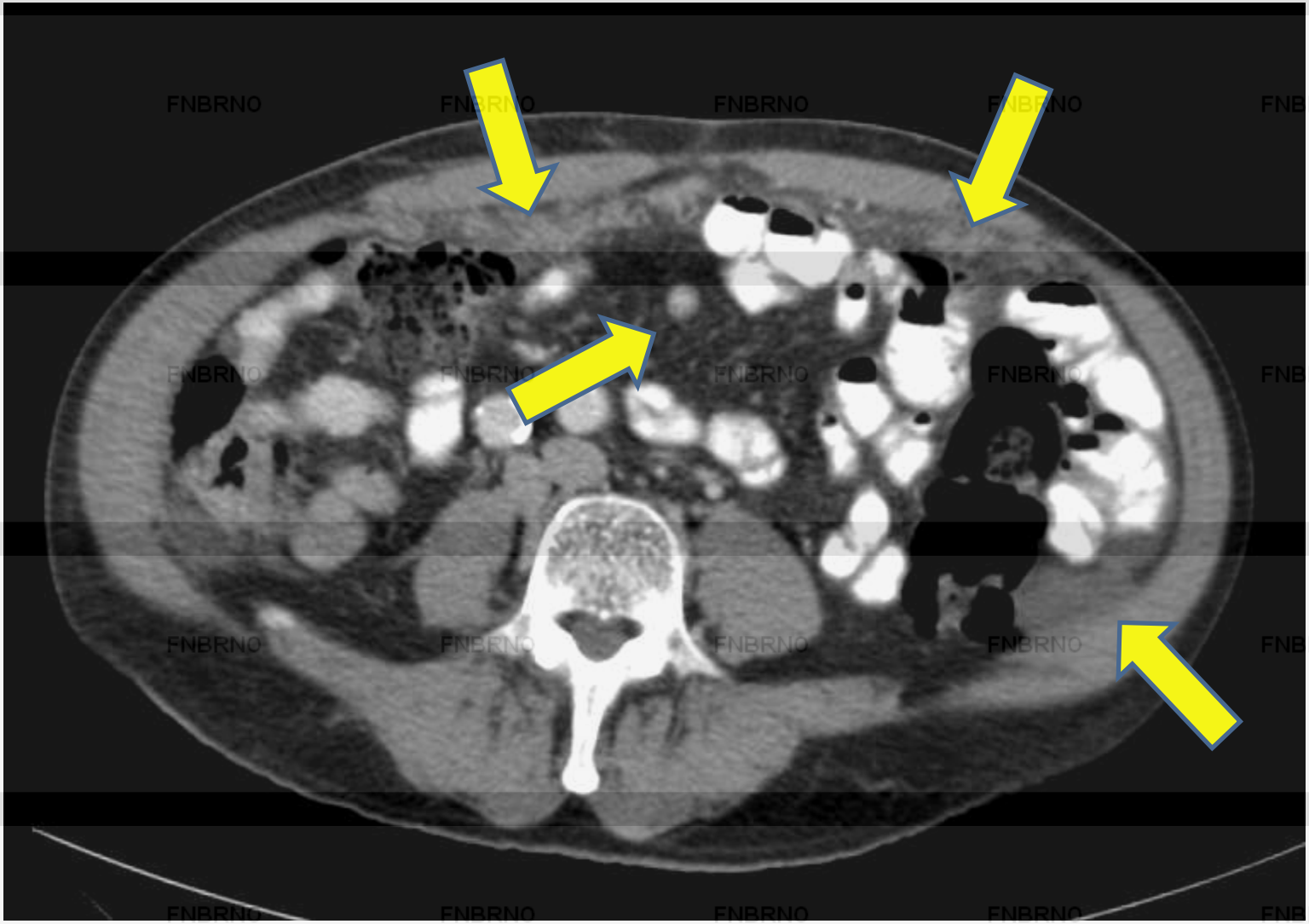


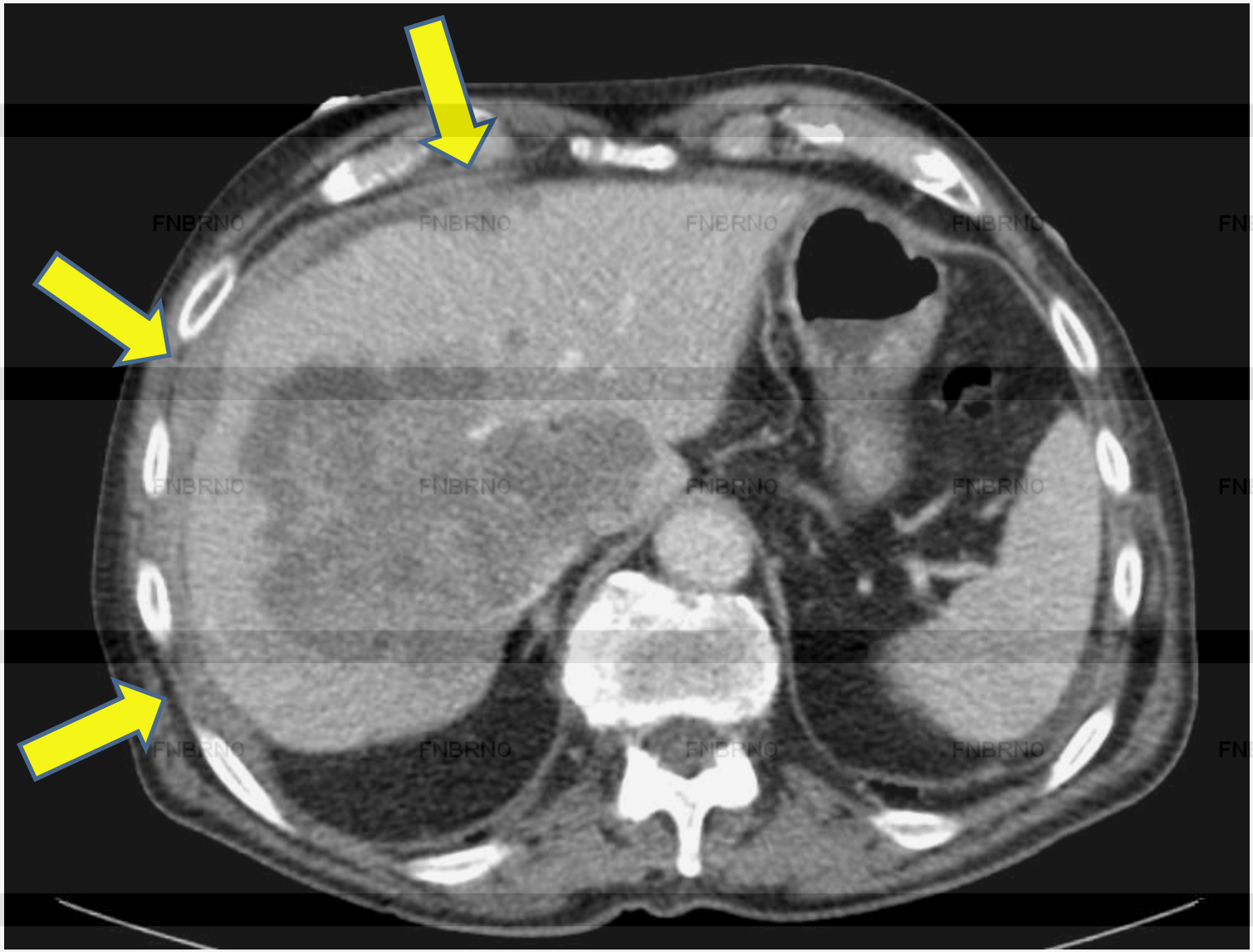






# Ca rektosigmoidea





# Staging

Gilly 1994 Lyon

- Jednoduchost a reproducibilita
- st.1-2 medián 6měsíců
- st.3-4 medián 3m (negynekologické malignity)

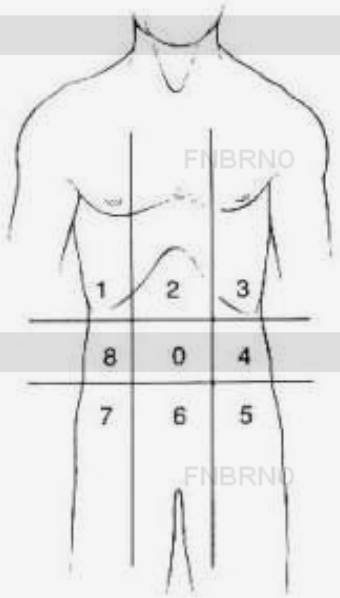
-- distribuce metastáz

Gilly peritoneal carcinomatosis staging.

| Stage | Peritoneal carcinomatosis description |
|---|---|
| Stage 0 | No macroscopic disease |
| Stage 1 | Malignant implants less than 5 mm in diameter Localized in one part of the abdomen |
| Stage 2 | Diffuse to the whole abdomen |
| Stage 3 | Malignant implants 5 mm to 2 cm |
| Stage 4 | Large malignant nodules (more than 2 cm) |

# PCI Harmon a Sugarbaker et.al.

## Peritoneal Cancer Index

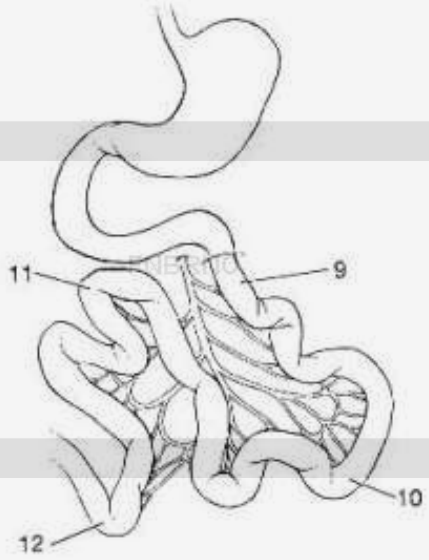



| Regions | Lesion Size |
|---|---|
| 0 Central | ____ |
| 1 Right Upper | ____ |
| 2 Epigastrium | ____ |
| 3 Left Upper | ____ |
| 4 Left Flank | ____ |
| 5 Left Lower | ____ |
| 6 Pelvis | ____ |
| 7 Right Lower | ____ |
| 8 Right Flank | ____ |
| 9 Upper Jejunum | ____ |
| 10 Lower Jejunum | ____ |
| 11 Upper Ileum | ____ |
| 12 Lower Ileum | ____ |

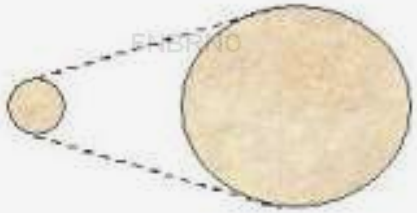
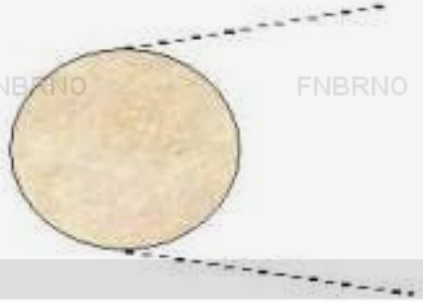
**PCI** ☐

**Lesion Size Score**

LS 0 No tumor seen
LS 1 Tumor up to 0.5 cm
LS 2 Tumor up to 5.0 cm
LS 3 Tumor > 5.0 cm or confluence



# Completness of cytoreduction

| CC-0 | CC-1 | CC-2 | CC-3 |
| --- | --- | --- | --- |
|  |  |  |  |
| No Disease | Present <0.25 cm | 0.25 cm - 2.5 cm | > 2.5 cm |

# Hodnocení na CT

- **Historie - 20. století**

- CT is an inaccurate test by which to quantitate peritoneal carcinomatosis from adenocarcinoma

- The malignant tissue progresses on the peritoneal surfaces and its shape conforms to the normal contours of the abdominal and pelvic structures. This is quite different from the metastatic processes in liver or lung, which progress as 3-dimensional tumor nodules.

Jacquet et al.

FNBRNO

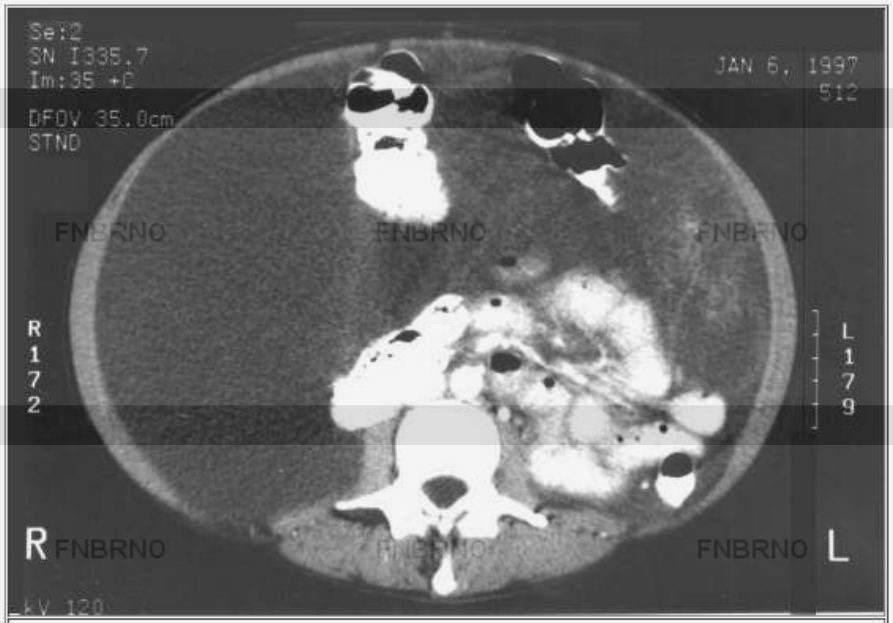
# Mucinózní adenokarcinom apendixu

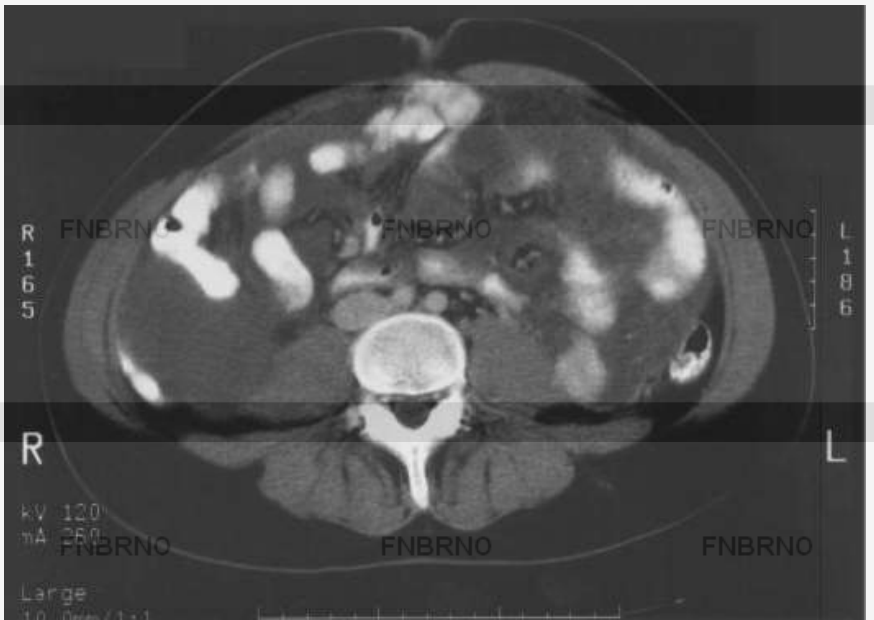
- Jacquet et al.

1. segmental obstruction of the small bowel,
2. tumour masses more than 5 cm in diameter associated with the small bowel and its mesentery.

++ 88% probability of incomplete resection

-- 92% probability of complete resection



# Diagnostické pneumoperitoneum

Abdom Imaging. 1995 Jan-Feb;20(1):52-5; discussion 56-7.

**Induced pneumoperitoneum in CT evaluation of peritoneal carcinomatosis.**

Caseiro-Alves F[1], Gonçalo M, Abraul E, Pinto E, Oliveira C, Ramos V.

⊕ **Author information**

**Abstract**

**BACKGROUND:** Imaging of peritoneal carcinomatosis is a well-known problem even for technologies as recent as computed tomography (CT). The purpose of this study was to evaluate whether CT performed after induced pneumoperitoneum (CT-PP) could have a higher sensitivity in the detection of peritoneal implants over conventional CT.

**METHODS:** Five patients with known ovarian malignancies underwent standard CT and CT-PP. Exploratory laparotomy was performed with a maximum interval of 7 days from the last imaging procedure. Results were prospectively compared with surgical findings on a compartment to compartment basis.

**RESULTS:** CT-PP was well-tolerated with no serious adverse reactions registered. The anterior and visceral peritoneum, the paracolic gutters and subphrenic areas were particularly well depicted but not the pelvis which was poorly evaluated in all cases. CT-PP detected all the three cases where peritoneal carcinomatosis was present even when metastatic nodules were smaller than 2 mm; it also showed intraabdominal adhesions in two patients, an important finding that precludes the use of intraperitoneal chemotherapy.

**CONCLUSIONS:** With CT-PP there seems to be a reduction in the threshold of detectability of peritoneal implants. The direct demonstration of intraperitoneal adhesions is an important secondary finding. Disadvantages of CT-PP are (1) it is a time-consuming method and (2) it does not evaluate all the peritoneal recesses potentially involved in peritoneal carcinomatosis.

\+ metastázy < než 2mm, adheze ( ip-chemoterapie)

\- dependentní části

# Aplikace k.l. intraperitoneálně

Gynecologic Oncology

Volume 52, Issue 2, February 1994, Pages 154–160

Regular Article

## Computerized Tomography of the Abdomen and Pelvis with Peritoneal Administration of Soluble Contrast (IPC-CT) in Detection of Residual Disease for Patients with Ovarian Cancer

G. Frasci, M.D., A. Contino, M.D., R.V. Iaffaioli, M.D., P. Persico, M.D.

Available online 29 April 2002

Abstract

Forty-five ovarian cancer patients were submitted to abdominopelvic computed tomography after intraperitoneal administration of soluble contrast in large fluid volumes (3 liters of normal saline) (IPC-CT), for a total of 66 exams. In all cases standard abdominopelvic CT scanning had previously missed the presence of disease. Peritoneal access was achieved by a temporary Teflon catheter inserted blindly. No major complications related to peritoneal access or fluid administration occurred. Laparotomy was performed in all cases to evaluate accuracy of this new diagnostic procedure. Overall, 32/66 exams showed no abnormal findings. In 9/32 cases persistence of disease was demonstrated by laparotomy. The remaining 34 exams were suggestive of persistence of tumor. In 19 cases CT scan showed nodular images or peritoneal thickness. Persistence of disease was confirmed by laparotomy in all instances. In 15 cases only an abnormal diffusion of soluble contrast into peritoneum (suprahepatic, anterior, or parietocolic region) was demonstrated. In 11/15 persistence of tumor was found at laparotomy. To summarize, IPC-CT revealed persistence of tumor in 30/39 cases (77% sensitivity). Positive results were predictive of persistence of disease in 30/34 cases (88% specificity). This new procedure was able to detect persistence of disease in most of our patients showing negative standard CT (30/39 vs 0/39; $P < 10E - 8$) and its diagnostic accuracy was even better than standard CT + serum tumor markers (30/39 vs 16/39; $P < 0.001$). In conclusion, IPC-CT could be very effective in monitoring response to treatment and could markedly reduce the number of ovarian cancer patients requiring second-look laparotomy.

# PCI vs CT 2004 Bree

Journal of Surgical Oncology 2004;86:64–73

## Peritoneal Carcinomatosis From Colorectal or Appendiceal Origin: Correlation of Preoperative CT With Intraoperative Findings and Evaluation of Interobserver Agreement

EELCO DE BREE, MD,[1]* WIM KOOPS, MD,[2] ROBERT KRÖGER, MD,[2] SERGE VAN RUTH, MD, PhD,[1]
ARJEN J. WITKAMP, MD, PhD,[1] AND FRANS A.N. ZOETMULDER, MD, PhD[1]
[1]Department of Surgical Oncology, The Netherlands Cancer Institute (Antoni van Leeuwenhoek Hospital), Amsterdam, The Netherlands
[2]Department of Radiology, The Netherlands Cancer Institute (Antoni van Leeuwenhoek Hospital), Amsterdam, The Netherlands

### Results

The presence of peritoneal carcinomatosis was detected in 60 and 76% of those patients by each of the radiologist. Detection of individual peritoneal implants was poor ($\kappa = 0.11/0.23$) and varied from 9.1%/24.3% for tumor size <1 cm to 59.3%/66.7% for tumor size >5 cm. Overall sensitivity, specificity, accuracy, positive (PPV) and negative predictive value (NPV) for tumor involvement per area were 24.5%/37.3%, 94.5%/90.4%, 53.0%/60.0%, 86.2%/84.4%, and 47.3%/50.8%, respectively. Accuracy of tumor detection varied widely per anatomic site. Statistically significant interobserver differences were noted, specifically for tumor size of 1–5 cm ($P = 0.007$) and localization on mesentery and small bowel ($\kappa = 0.30$, $P = 0.04$).

### Conclusions

In colorectal cancer, CT detection of peritoneal carcinomatosis is moderate and of individual peritoneal tumor deposits poor. Interobserver differences are statistically significant. Therefore, preoperative CT seems not to be a reliable tool for detection of presence, size, and location of peritoneal tumor implants in view of treatment planning in patients with colorectal cancer. J. Surg. Oncol. 2004;86:64–73. © 2004 Wiley-Liss, Inc.

# 2008

Preoperative staging is most commonly performed using computed tomography (CT) scanning. International workshop on peritoneal surface malignancy devised an expert consensus statement concluding that contrast enhanced CT scans are the preferred modality to assess a patient's suitability for CRS.

Yan TD, Morris DL, Shigeki K, et al. Preoperative investigations in the management of peritoneal surface malignancy with cytoreductive surgery and perioperative intraperitoneal chemotherapy: expert consensus statement. J Surg Oncol 2008;98:224–7.

However, CT has been identified

as a poor predictor of intraoperative PCI (oPCI)

FNBRNO

# PCI vs CT PCI CRC - 2009

- Velikost uzlů : přesně zobrazeno 60%, podhodnoceno 33%, anadhodnoceno 7%
- Hodnocení nejlepší – epigastrium, levý nadbřišek, levé mesogastrium
- Malé uzly (<0.5 cm) na CT zobrazeny se senzitivitou 11%, při velikosti nad 5cm 94%
- Radiological PCI scores significantly underestimated intraoperative PCI (P < 0.001).

Ann Surg Oncol (2009) 16:327–333
DOI 10.1245/s10434-008-0234-2

Annals of
SURGICAL ONCOLOGY
OFFICIAL JOURNAL OF THE SOCIETY OF SURGICAL ONCOLOGY

ORIGINAL ARTICLE – GASTROINTESTINAL ONCOLOGY

## Evaluation of Preoperative Computed Tomography in Estimating Peritoneal Cancer Index in Colorectal Peritoneal Carcinomatosis

**Ju-Li Koh, BSc (Med)[1], Tristan D. Yan, BSc (Med), MBBS, PhD[1], Derek Glenn, MBBS[2], and David L. Morris, MD, PhD[1]**

[1]Department of Surgery, St. George Hospital, University of New South Wales, Sydney, NSW, Australia; [2]Department of Radiology, St. George Hospital, University of New South Wales, Sydney, NSW, Australia

**ABSTRACT** Peritoneal Cancer Index (PCI) has been recognized as an independent prognostic indicator for long-term outcomes. It also influences the likelihood of complete cytoreduction, another principal determinant of long-term survival. The objective of this study was to evaluate the utility of preoperative CT in estimating PCI during the patient selection process. The efficacy of CT in demonstrating peritoneal disease was evaluated by comparing the radiological and intraoperative lesion size and PCI scores using the Wilcoxon signed-rank test. Tumor distribution was assessed in each abdominopelvic region as tumor present versus absent. The sensitivity, specificity, positive predictive value, and negative predictive value were calculated in each abdominopelvic region. Overall, where CT identifies the presence of disease, it portrayed lesion size accurately in 60%, underestimated in 33%, and overestimated in 7% of cases. Analysis of individual abdominopelvic regions demonstrated a statistically significant difference between radiologically and intraoperatively visualized lesion sizes ($P < 0.05$) except in the epigastrium, left upper, and left flank regions. The sensitivity of CT in detecting peritoneal implants was influenced by lesion size. Small nodules (<0.5 cm) were visualized on CT with only a sensitivity of 11%, which is in contrast to 94% with nodules exceeding 5 cm. Radiological PCI scores significantly underestimated intraoperative PCI ($P < 0.001$). This study demonstrated that the sensitivity of CT in detecting peritoneal implants was influenced by lesion size and CT PCI significantly underestimated clinical PCI. The role of CT in refining patient selection and improving prognosis remains to be closely evaluated.

© Society of Surgical Oncology 2008

First Received: 8 September 2008;
Published Online: 3 December 2008

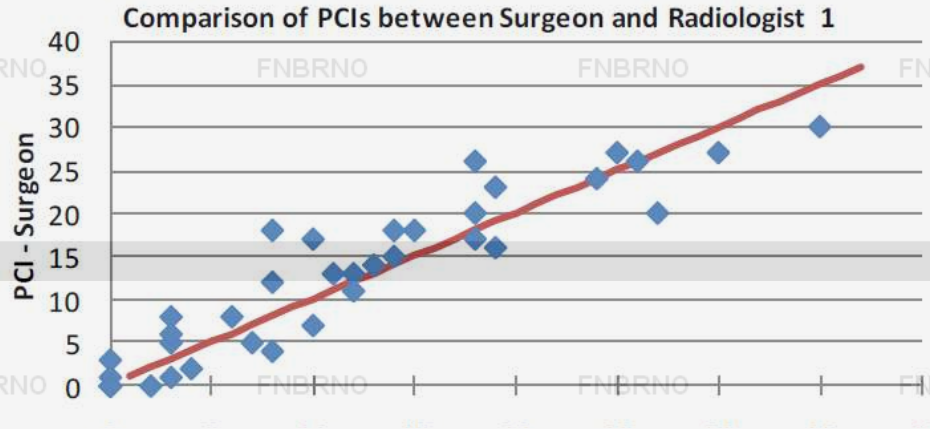
D. L. Morris, MD, PhD
e-mail: david.morris@unsw.edu.au

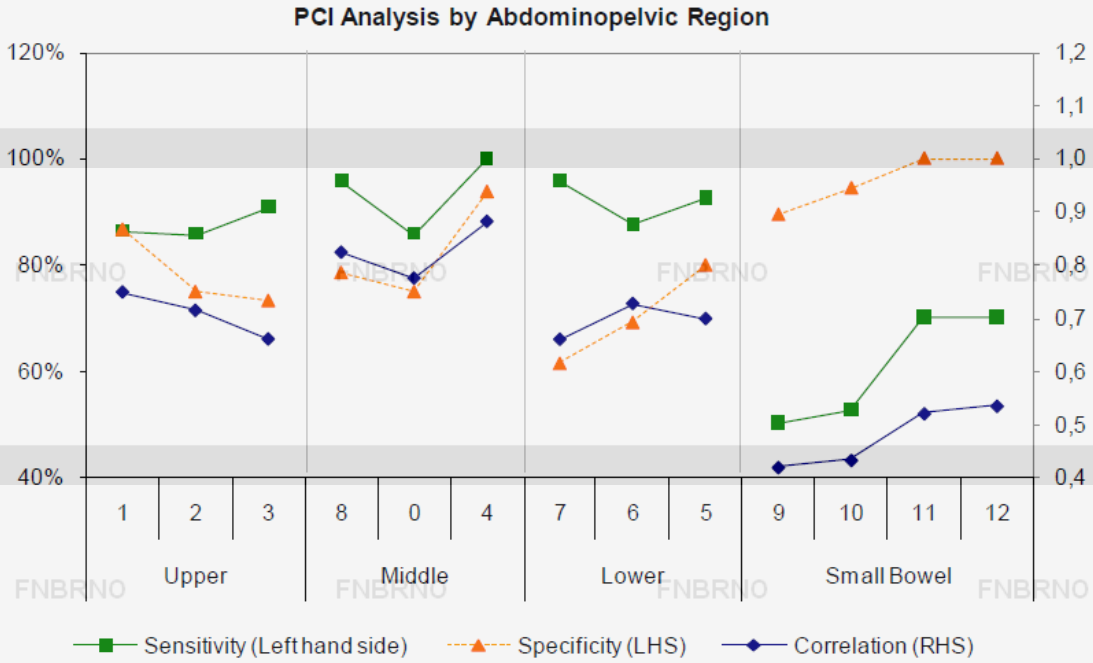
Colorectal peritoneal carcinomatosis (CRPC) is associated with a median survival of 5.2 to 7 months after palliative management.[1–3] It was regarded as an invariably terminal condition. A recent randomized, controlled trial (RCT) that compared cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) with systemic chemotherapy and palliative surgery demonstrated a significantly improved survival.[4] Numerous phase II studies also have shown promising outcomes.[5–7] However, this combined treatment approach remains controversial because the procedure is associated with considerable perioperative morbidity.[8–10] Stringent patient selection is critical to ensure optimal benefit from this comprehensive treatment.

Peritoneal Cancer Index (PCI), a scoring system that quantifies the extent of carcinomatosis, is recognized as an independent prognostic indicator for long-term outcomes in CRPC.[4,11–13] It also influences the likelihood of complete cytoreduction, another principal determinant of long-term survival. It has been demonstrated that a large volume of disease is associated with poor long-term survival in CRPC even if complete cytoreduction is achieved.[11] Therefore, identification of such patients preoperatively is desirable. The important question is whether one can predict PCI or operability before CRS by utilizing high-resolution contrast-enhancing multislice computed tomography (CT) scans.

During the Fifth International Workshop on Peritoneal Surface Malignancy in Milan, a consensus was reached on CT as the principal imaging modality to assess patient suitability for CRS.[14] However, there are limited data on the accuracy of CT in this undertaking. Review of the available literature showed considerable variability in the accuracy of CT in depicting peritoneal involvement of gastrointestinal and ovarian malignancies.[15–18] Its sensitivity is site and lesion size-dependent. However, no studies have been conducted exclusively on CRPC, where PCI is acknowledged as being most prognostic. The objective of this study was to

# PCI vs CT PCI 2011




Duhr et al. World Journal of Surgical Oncology 2011, 9:171
http://www.wjso.com/content/9/1/171

WORLD JOURNAL OF SURGICAL ONCOLOGY

RCH Open Access

nizing of preoperative computed
graphy for diagnosis in patients with
oneal carcinomatosis

uhr[1,2], Werner Kenn[1], Ralph Kickuth[1], Alexander G Kerscher[2], Christoph-Thomas Germer[2],
n[1] and Joerg O W Pelz[2*]

d and Objective: This study evaluates whether Computer Tomography is an effective procedure for
e staging of patients with Peritoneal Carcinomatosis.
sample of 37 patients was analyzed with contrast enhanced abdominal Computer Tomography,
surgical staging. All Computer Tomography scans were evaluated 3 times by 2 radiologists with one
reviewing 2 times. The efficacy of Computer Tomography was evaluated using the Spearman correlation
relations were analyzed by abdominopelvic region to assess results of the Peritoneal Carcinomatosis
gregating the 13 regions. Surgical findings were compared to radiological findings.
s indicate high correlations between the surgical and radiological Peritoneal Carcinomatosis Indices.
e intra-class correlation between the first and second reading of one radiologist suggest high intra-
ility. Correlations by abdominopelvic region show higher values in the upper and middle regions
ower values in the lower regions and the small bowel (correlation coefficients range between 0.418
0.010; sensitivities range between 50% and 96%, and specificities range between 62% and 100%).
omputer Tomography represents an effective procedure in the preoperative staging of patients with
esults by abdominopelvic region show lower correlation, therefore suggest lower efficacy. These
ported by analyses of sensitivity and accuracy by lesion size. This suggests that Computer
s an effective procedure for pre-operative staging but less for determining a tumor's accurate extent.

rcinomatosis, PCI, diagnosis

inomatosis ("PC") is a common metasta-
many tumor variances with high inci-
ng in ovarian, gastric, and colorectal
rature, the occurrence frequencies for
stases in ovarian, gastric, and colorectal
t to 71%, 17%, and 10%, respectively
natural history, PC is commonly asso-
k prognosis [3].
as therapeutic procedures for PC exist
s being dependent on the PC's location

and extent. The existence of peritoneal disease leads to different therapeutic procedures including exclusive use of systemic chemotherapy, cytoreductive surgery combined with or without hyperthermic intra-abdominal intra-peritoneal chemotherapy or exclusive palliative management. In order to achieve a highly selective group of patients a wide array of complex therapeutic procedures constitutes the current state of clinical research, including curative focused cytoreductive surgery ("CS") and hyperthermic intraperitoneal chemoperfusion ("HIPEC") [4-12].

Elias *et al.* demonstrated a median survival of 5 years with a 51% survival rate which is achieved by applying the HIPEC approach in a sample of well selected patients with PC of colorectal origin [13]. To ensure

tz_j@klinikum-wuerzburg.de
ah, Visceral-, and Paediatric Surgery, University of
rmation is available at the end of the article

el Central
© 2011 Duhr et al.; licensee BioMed Central Ltd. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

# CTI vs CT - 2014

The American Journal of Surgery (2014) 207, 760-765

The American Journal of Surgery

North Pacific Surgical Association

## Preoperative computed tomography does not predict resectability in peritoneal carcinomatosis

Justin D. Rivard, M.D., F.R.C.S.C.*, Walley J. Temple, M.D., F.R.C.S.C., F.A.C.S., Yarrow J. McConnell, M.D., F.R.C.S.C., Hisham Sultan, M.D., Lloyd A. Mack, M.D., F.R.C.S.C., F.A.C.S.

*Department of Surgery and Oncology, University of Calgary, Calgary, A*

KEYWORDS: Peritoneal carcinomatosis; Cytoreduction; Computed tomography; Resectability

Abstract

BACKGROUND: Obtaining a complete cyto
is one of the most significant prognostic varia
on preoperative computed tomography (CT)
METHODS: A retrospective case-control st
and 15 patients with completely resected PC
and pathology type. Two surgical oncologists
RESULTS: PCI estimated on imaging was
icantly underestimated intraoperative PCI me
associated with unresectability. However, pati
to be unresectable (87.5% vs 36.4%, $P$ = .03
CONCLUSIONS: Two or more concerning C
risk of unresectability in patients with PC.
patient from an attempted cytoreduction.
© 2014 Elsevier Inc. All rights reserved.

Peritoneal carcinomatosis (PC) occurs in 10% to 40% of gastrointestinal malignancies either at initial presentation or upon disease recurrence.[1,2] Encouraging progress has been made in recent years toward the treatment of patients with peritoneal metastasis with the use of cytoreduction surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC). One randomized trial and several prospective cohort trials hav survival palliative However erable m which p unresecta fore, ide from thi desirable.

The Peritoneal Cancer Index (PCI) is a scoring system that quantifies the severity of PC. The extent of disease is scored on a scale with a maximum value of 39 by dividing the abdomen into 13 distinct regions, as described by Harmon and Sugarbaker.[9] The PCI has been shown to

There were no relevant financial relationships or any sources of support in the form of grants, equipment, or drugs.
* Corresponding author. Tel.: +1-403-521-3030; fax: +1-403-521-3744.
E-mail address: Justin.Rivard@albertahealthservices.ca
Manuscript received October 28, 2013; revised manuscript December 21, 2013

0002-9610/$ - see front matter © 2014 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.amjsurg.2013.12.024

## Abstract

**BACKGROUND:** Obtaining a complete cytoreduction in patients with peritoneal carcinomatosis (PC) is one of the most significant prognostic variables for long-term survival. This study explored features on preoperative computed tomography (CT) to predict unresectability.

**METHODS:** A retrospective case–control study was conducted of 15 patients with unresectable PC and 15 patients with completely resected PC matched by intraoperative peritoneal cancer index (PCI) and pathology type. Two surgical oncologists blindly analyzed all abdominopelvic CT scans.

**RESULTS:** PCI estimated on imaging was not higher in unresectable patients ($P$ = .851) and significantly underestimated intraoperative PCI measurement ($P$ = .003). No single concerning feature was associated with unresectability. However, patients with 2 or more concerning features were more likely to be unresectable (87.5% vs 36.4%, $P$ = .035).

**CONCLUSIONS:** Two or more concerning CT imaging features appear to be associated with a higher risk of unresectability in patients with PC. However, no specific imaging feature should exclude a patient from an attempted cytoreduction.
© 2014 Elsevier Inc. All rights reserved.

Specificity was nearly unchanged for all the four radiologists. Sensitivity improved for the most experienced and the least experienced radiologists and was unchanged for the two readers with intermediate skills. Except for the third step of radiologist 4, no statistically significant differences in diagnostic performance were detected. The diagnostic confidence of all the four readers benefited to variable degrees from interpretation of the 1-mm slices and MPRs.

Conclusions:

**5-mm řezy dostatečné k detekci peritonealní karcinomatózy**

**1-mm řezy and MPR mohou zlepšit senzitivitu a diagnostickou jistotu (zejména u mladých)**

Abdominal Imaging

© Springer Science+Business Media, LLC 2008
Published online: 9 February 2008

Abdom Imaging (2009) 34:49–54
DOI: 10.1007/s00261-008-9372-z

# Multi-detector CT in peritoneal carcinomatosis: diagnostic role of thin slices and multiplanar reconstructions

Tobias Franiel,[1] Gerd Diederichs,[1] Florian Engelken,[1] Thomas Elgeti,[1] Juliane Rost,[2] Patrik Rogalla[1]

[1]Department of Radiology, Charité Universitätsmedizin, Campus Charité Mitte, Schumannstraße 20-21, Berlin, 10098, Germany
[2]Obstetrics and Gynecoloy, Klinikum Ernst von Bergmann gGmbH, Charlottenstrasse 72, Potsdam, 14467, Germany

## Abstract

*Background:* In order to investigate whether 1-mm thin slices and multiplanar reconstructions (MPRs) of multi-detector computed tomography (CT) datasets interpreted in addition to isotropic 5-mm thick slices in one session improve the detection of peritoneal carcinomatosis.

*Methods:* The abdominal CT datasets of 44 patients with histologically proven tumors of the abdomen or pelvis were retrospectively evaluated for peritoneal carcinomatosis by four radiologists with variable experience (radiologist 1: ≥10 years, radiologists 2 and 3: 1.5 years, radiologist 4: 0.5 years). In three successive steps, the radiologists evaluated first the axial 5-mm slices, second the 1-mm slices, and third the MPRs and rated their diagnostic confidence.

*Results:* Specificity was nearly unchanged for all the four radiologists. Sensitivity improved for the most experienced and the least experienced radiologists and was unchanged for the two readers with intermediate skills. Except for the third step of radiologist 4, no statistically significant differences in diagnostic performance were detected. The diagnostic confidence of all the four readers benefited to variable degrees from interpretation of the 1-mm slices and MPRs.

*Conclusions:* While 5-mm slices are sufficient for the detection of peritoneal carcinomatosis, 1-mm slices and MPRs can improve sensitivity and diagnostic confidence.

*Correspondence to:* Tobias Franiel; *email:* tobias.franiel@charite.de

**Key words:** Peritoneal carcinomatosis—MDCT—Multiplanar reconstructions—MPR—Computed tomography

Peritoneal carcinomatosis occurs in a wide range of malignant tumors such as ovarian, gastrointestinal, endometrial, urothelial, and breast cancer as well as malignant melanoma [1–4]. Seeding of the peritoneal cavity occurs as a result of circulation of peritoneal fluid after the metastatic spread of a primary tumor [5–7]. Peritoneal carcinomatosis can manifest as nodular or plaque-like lesions, ascites, or the tumorous infiltration of mesenteric fatty tissue [8]. Patients with peritoneal implants have an unfavorable prognosis. In a review of studies including patients with different primary tumors, mean survival was 1–8 months in patients with malignant ascites [9] and 5–32 months in patients with peritoneal metastases from colorectal cancer [10]. Therefore, reliable confirmation or the exclusion of peritoneal carcinomatosis is important for the individual patient's prognosis and therapeutic management.

Computed tomography (CT) is the most widely used imaging modality for diagnosing peritoneal carcinomatosis. Studies including patients with different primary tumors reported sensitivities ranging from 41% to 79% and a specificity of up to 100% [3, 11–13]. For detection of peritoneal carcinomatosis in patients with ovarian cancer, sensitivity was found to be as high as 85% to 93% [14, 15]. These results were obtained with single-row CT scanners. Multidetector-row CT (MDCT) technology shortens the examination time and allows the generation of thin slices with subsequent multiplanar reconstruction (MPR). This new CT technique has been

# CT vs PET/CT

Anticancer Res. 2014 May;34(5):2363-8.

## Preoperative assessment of peritoneal carcinomatosis in patients undergoing hyperthermic intraperitoneal chemotherapy following cytoreductive surgery.

Pasqual EM[1], Bertozzi S, Bacchetti S, Londero AP, Basso SM, Santeufemia DA, Lo Re G, Lumachi F.

Author information

**Abstract**

The present study evaluates the accuracy of computed tomographic (CT) scan and positron emission tomography with (18)F-fluorodeoxyglucose (FDG-PET)/CT for the quantification of peritoneal carcinomatosis (PC) in patients undergoing cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC). Data were retrospectively collected for 58 patients, who were considered for CRS and HIPEC. The predictability, sensitivity, specificity and accuracy values of FDG-PET/CT and CT were tested. Preoperative CT and FDG-PET/CT failed to detect PC in 9% and 17% of cases, respectively, with a sensitivity of 91% and 82%, a specificity of 33% and 67%, an area under the curve (AUC) of 62% and 74% and a negative likelihood ratio of 0.27 (CI.95 0.07-1.09) and 0.27 (CI.95 0.11-0.62), respectively (p=0.469). Both techniques showed a high prevalence of PC extent underestimation (CT 47% and FDG-PET/CT 43% of cases). Small bowel involvement and optimal CRS had a prevalence of 60% and 76%, respectively, and both the CT and FDG-PET/CT imaging techniques were inaccurate at predicting them (AUC 53% and 52% for small bowel involvement, and 63% and 58% for optimal CRS, respectively). In conclusion both CT and FDG-PET/CT had low preoperative staging reliability for PC, and this can strongly influence the ability to implement the correct treatment strategy for patients with PC.

**KEYWORDS:** CRS; CT; HIPEC; PET; PET/CT; Peritoneal carcinomatosis; computed tomography; cytoreductive surgery; hyperthermic intraperitoneal chemotherapy; positron emission tomography

# MR a PCI

*Cancer Imaging* (2013) **13(4)**, 540–547
DOI: 10.1102/1470-7330.2013.0044

ORIGINAL ARTICLE

## Correlation of preoperative magnetic resonance imaging of peritoneal carcinomatosis and clinical outcome after peritonectomy and HIPEC after 3 years of follow-up: preliminary results

**B. Klumpp[a], P. Aschoff[b], N. Schwenzer[a], I. Koenigsrainer[c], S. Beckert[c], C.D. Claussen[a], S. Miller[d], A. Koenigsrainer[c], C. Pfannenberg[a]**

*[a]Eberhard-Karls-University Tuebingen, Department for Diagnostic and Interventional Radiology, Hoppe-Seyler-Strasse 3, 72076 Tuebingen, Germany [b]Diakonie Klinikum Stuttgart, Südwestdeutsches PET-Zentrum, Seidenstrasse 47, 70174 Stuttgart, Germany [c]Eberhard-Karls-University Tuebingen, Department for General, Visceral and Transplantation Surgery, Hoppe-Seyler-Strasse 3, 72076 Tuebingen, Germany [d]Radiologiepraxis Dr Aicher, Dr Kölbel, Prof Dr Miller, Uhlandstrasse 8, 72072 Tuebingen, Germany*

*Corresponding address: Bernhard Daniel Klumpp, Eberhard-Karls-University Tuebingen, Department for Diagnostic and Interventional Radiology, Hoppe-Seyler-Strasse 3, 72076 Tuebingen, Germany*
*Email:* bernhard.klumpp@med.uni-tuebingen.de

Date accepted for publication 17 September 2013

**Abstract**

**Purpose**: In patients with peritoneal carcinomatosis, cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) is an evolving approach with curative intention. Previous studies indicate a correlation between preoperative magnetic resonance imaging (MRI) and surgical findings regarding the extent of peritoneal carcinomatosis. The aim of this study was to assess retrospectively whether preoperative MRI can predict the outcome and is therefore a suitable tool for patient selection. **Materials and methods**: Fifteen patients with laparoscopically proven peritoneal carcinomatosis were preoperatively examined using a 1.5-T whole-body MRI system. Results were correlated with surgical exploration. Follow-up was done by contrast-enhanced abdominal computed tomography and, if suspicious for recurring disease, laparoscopy or laparotomy. Survival time and interval to recurring disease were correlated with the preoperative peritoneal carcinomatosis index (PCI) on MRI (Spearman's rank correlation). **Results**: In five patients radical resection could not be achieved (PCI 34 ± 6.9); survival time was 78.2 ± 54.1 days. In seven patients recurring disease was found 430 ± 261.2 days after initial complete cytoreduction (PCI 11.6 ± 6.9); survival time was 765.9 ± 355 days. Two patients are still alive after 3 years. Two patients with initially complete cytoreduction are without recurring disease after 3 years (PCI 5 and 12). One patient was lost for follow-up. **Conclusions**: Results of the preoperative MRI correlate well with the surgical PCI, postoperative resection status, and survival time. MRI might be a suitable technique for patient selection when considering peritonectomy and HIPEC. In our patients the outcome seems to correlate well with the extent of peritoneal carcinomatosis found by the preoperative MRI.

**Keywords:** *Peritoneal carcinomatosis; cytoreductive surgery; magnetic resonance imaging; hyperthermic intraperitoneal chemotherapy.*

### Introduction

Peritoneal carcinomatosis (PC) occurs in a variety of malignant diseases at a progressive stage of the underlying disease. In general, patient prognosis is poor when PC is diagnosed[1]. In recent years, peritonectomy with multivisceral resection of all involved viscera combined with hyperthermic intraperitoneal chemotherapy (HIPEC) has been regarded as an approach with curative intention even at such a disease stage[2]. To achieve this goal, complete cytoreduction is mandatory[3–5].

When considering peritonectomy, tumor spread has to be assessed carefully preoperatively to enable optimal

### *Examination protocol*

To assess the extent of PC, all patients were examined on a 1.5-T whole-body MRI system using 2 phased-array surface coils (Magnetom Avanto; Siemens Health Care, Erlangen, Germany). All sequences were acquired using the breath-hold technique. The examination protocol included dynamic contrast-enhanced high-resolution three-dimensional (3D) $T_1$-weighted gradient-echo (GRE), $T_2$-weighted turbo spin-echo, $T_2$-weighted 3D true-fast imaging, $T_2$-weighted half-Fourier acquisition turbo spin-echo, and contrast-enhanced $T_1$-weighted two-dimensional GRE sequences[10]. Prior to contrast injection and 35 s, 70 s, and 105 s after injection of 0.15 mmol gadolinium chelate per kilogram body weight (flow: 2 ml/s), contrast-enhanced $T_1$-weighted GRE sequences were acquired. Sequence parameters are given in Table 1. Patient preparation included 40 mg butylscopalamine intravenously to reduce intestinal motion artifacts, and oral administration of 2000 ml mannitol solution (2.5%) for intestinal distention.

# 4. Možnosti léčby

- Cytoredukce
  - techniky elektrochirurgie ( elektrokauterizace )
  - nikdy bez následné intraperitoneální chemoterapie

- Chemoterapie – intraperitoneální
  - - schopné penetrace jen do hloubky 1mm
  - - distribuce léčiva (srůsty, fibrinové depozita – zajízvení tum. buněk

FNBRNO

# Intraperitoneální chemoterapie

Mirnezami R *et al*. Multimodal treatment of colorectal peritoneal metastases

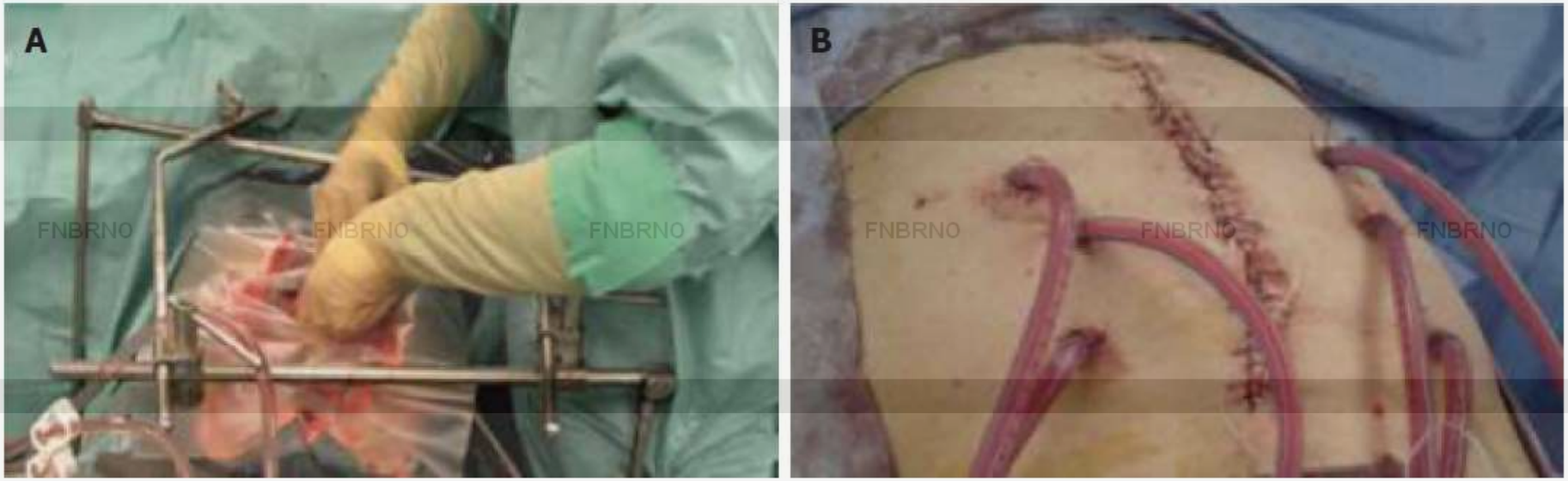



**Figure 2 Open (A) and closed (B) methods of intraperitoneal chemotherapy.**

FNBRNO

# Indikace

1. Velké objemy – neinvazivní peritoneální karcinomatózy nebo sarcomatózy
2. Peritoneální mesoteliom
3. Malý objem peritoneálního rozsevu invazivního tumoru
4. Perforované gastrointestinální tumory
5. Nádory infiltrující okolní orgány
6. Gastrointestinální tumory s pozitivní cytologii
7. Gastrointestinální tumory s postižením ovarii
8. Peroperativní diseminace (ruptura..)
9. Rekurentní ovariální nádor s dlouhým disease free intervalem
10. Paliace pacientů s maligním ascitem

FNBRNO

# Indikace a přežití

- **mCRC** PCI ≤ 10 50% 5leté přežití
  11-20 20%
  > 20 0%

- PCI ≤ 20 vhodné pro CRS a HIPEC
- **ca žaludku** PCI < 10 - ≤15
- **sarcomatóza** PCI < 13 74% 5leté přežití
  > 13 11%
- **Pseudomyxom peritonea a mesoteliom** PCI **není KI**

FNBRNO

# HIPEC + cytoredukce

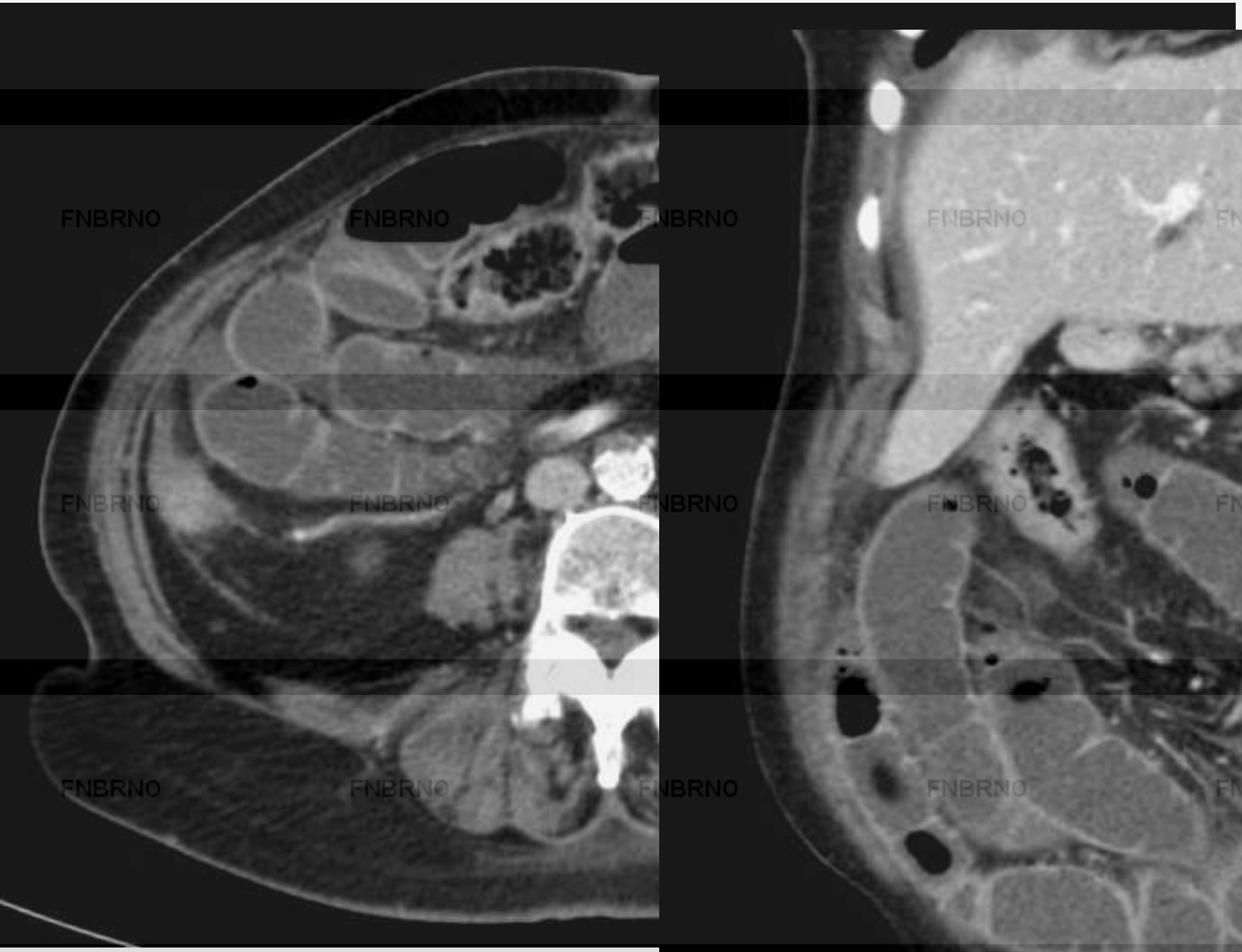
- **CRC** Verwall 22,2m vs. 12,6m
  - CCR- 0/1 medián přežití 48m, 45% 5-leté p.

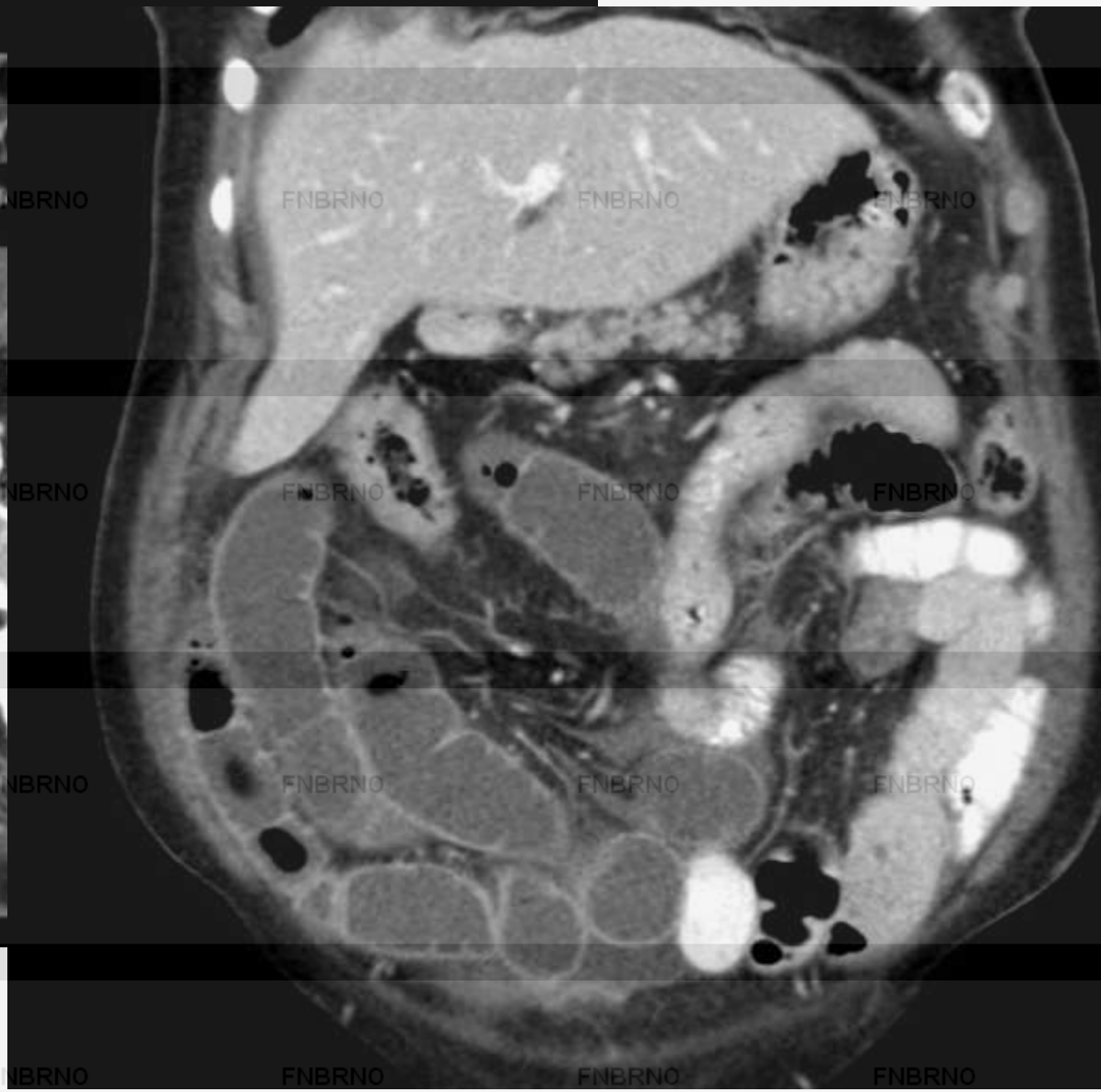
    Mahteme 32m vs. 14m, 28% vs.5% (5-leté p.)

- **GC** – zlepšené přežití - medián 10-19m, 21-32% 5-leté p. po CCR0/1

- Stage III/IV **ovarian cancer** – medián 28-46m

FNBRNO





# Závěr

- PCI nejrozšířenější v hodnocení peritoneální karcinomatózy
- CT  (epigastrium, levý nadbříšek, levé mesogastrium, uzly větší než 0,5cm)
- CT vzácně nadhodnocuje velikost lézí
- Pro kolorektální karcinom CTI<20 indikací pro cytoredukční  a intraoperativní chemoterapii
- i MR

# Děkuji za pozornost

tandrasina@fnbrno.cz