UNIVERSITA' DEGLI STUDI DI BARI

FACOLTA' DI MEDICINA E CHIRURGIA

Sezione di Diagnostica per Immagini

DIRETTORE:

Prof. Giuseppe Angelelli

METASTASI OSSEE: imaging

Arnaldo Scardapane

Le ossa sono una delle sedi più frequenti di diffusione delle neoplasie maligne

Le metastasi sono i tumori ossei più frequenti.

PRINCIPALI VIE DI DIFFUSIONE DEI TUMORI ALL'OSSO

- ESTENSIONE DIRETTA
- VIA EMATICA
- VIA LINFATICA
- DIFFUSIONE INTRASPINALE

NEOPLASIE CON FREQUENTI METASTASI OSSEE

- PROSTATA
- MAMMELLA
- POLMONE
- TIROIDE
- RENE

METODICHE D’IMAGING

- Radiologia tradizionale
- Tomografia Computerizzata (TC)
- Risonanza Magnetica Nucleare (RMN)
- Medicina Nucleare
  - ✓ SCINTIGRAFIA OSSEA
  - ✓ PET-TC

Radiologia Tradizionale – vantaggi

- Indagine diagnostica disponibile ovunque
- Bassi costi

Radiologia Tradizionale – svantaggi

- Bassa sensibilità specie per le lesioni non circondate da sclerosi
- Basso valore predittivo negativo
- **Dose**

Radiologia Tradizionale – lesioni litiche

Radiologia Tradizionale – lesioni osteoaddensanti

Tomografia Computerizzata – vantaggi

- Esame ad elevata “risoluzione spaziale”
- Facile disponibilità
- Possibilità di un rapido studio di tutto il corpo
- Valutazione contestuale di altri organi possibile sede di metastasi
- Studio ottimale dell’osso anche senza iniezione di mdc

Tomografia Computerizzata

È l'esame di scelta per la stadiazione degli organi Toracici-Addominali-Pelvici

↓

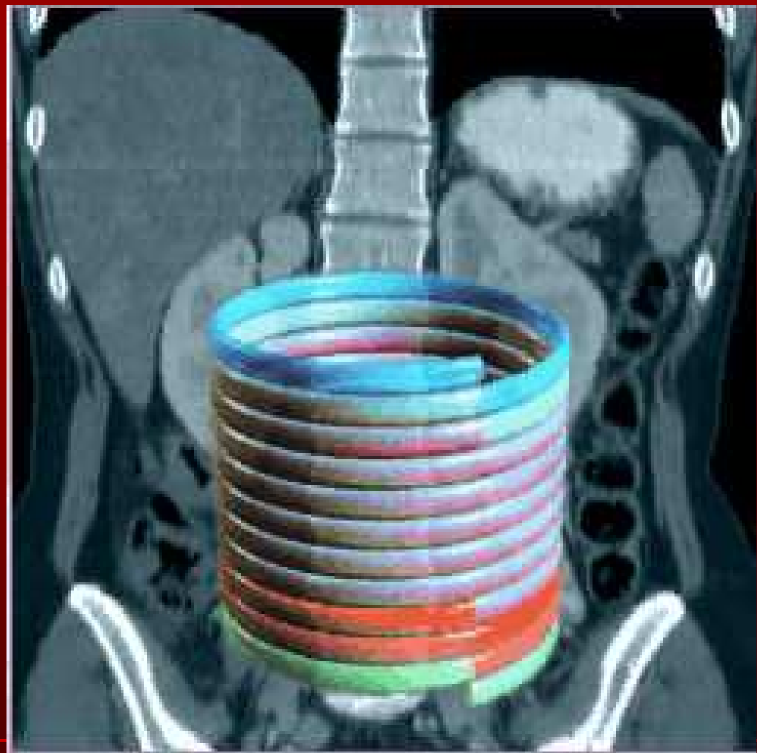
È doveroso da parte del radiologo studiare le strutture scheletriche con apposite finestre di visualizzazione

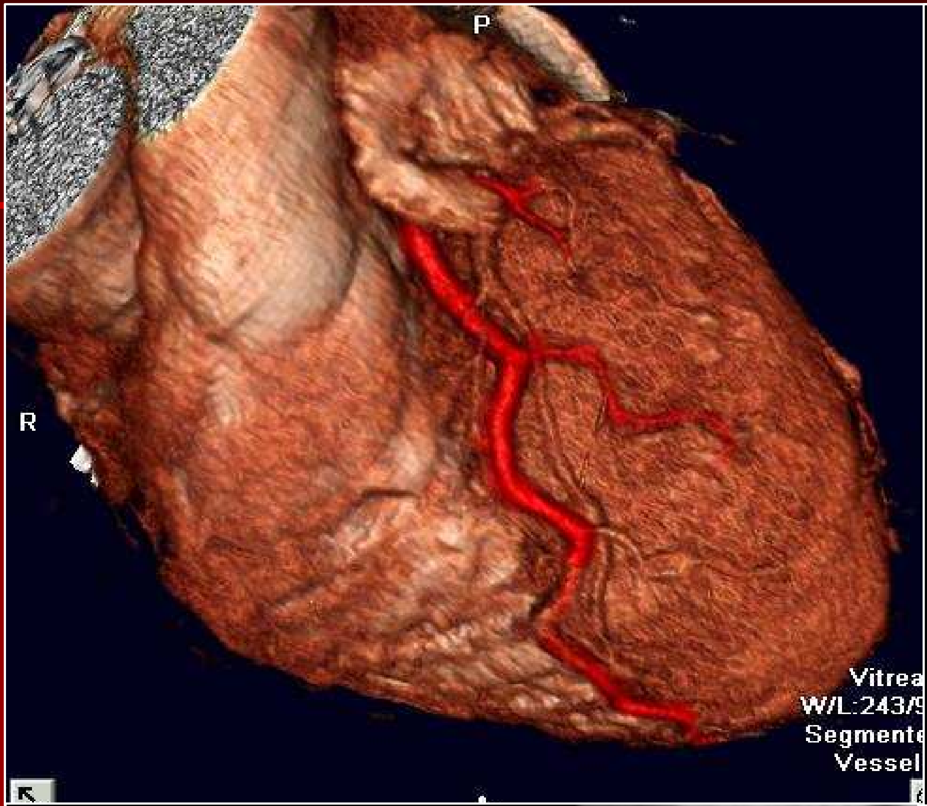
Tomografia Computerizzata – svantaggi

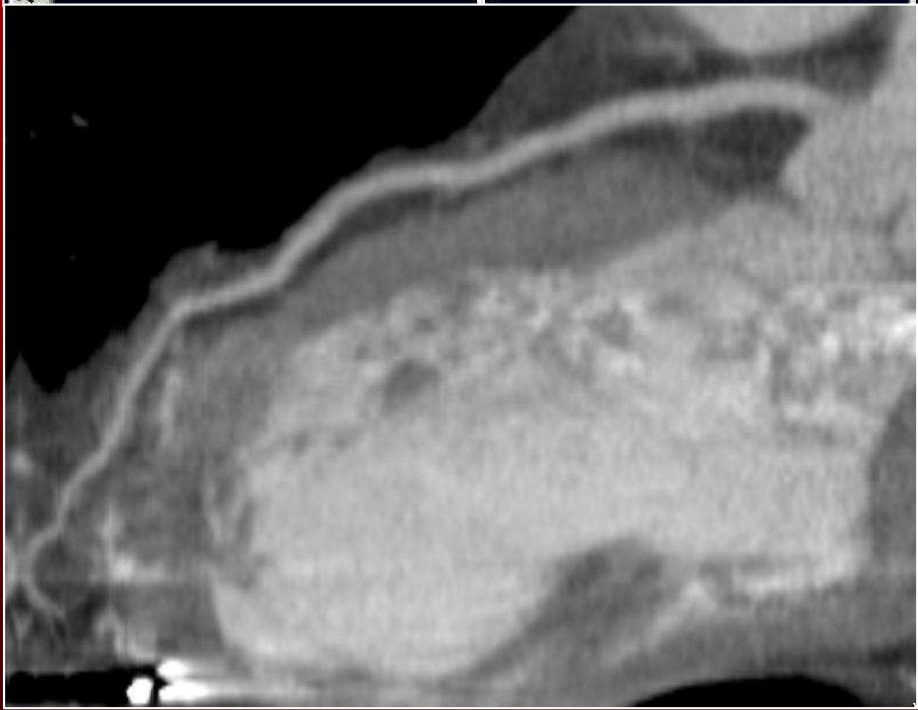
- **Elevata dose radiazioni**
- Costi relativamente elevati
- Basso valore predittivo negativo
- Bassa risoluzione di contrasto

Tomografia Computerizzata Multidetettore

150 cm in un' unica APNEA




P
R
Vitrea
W/L:243/9
Segmente
Vessel



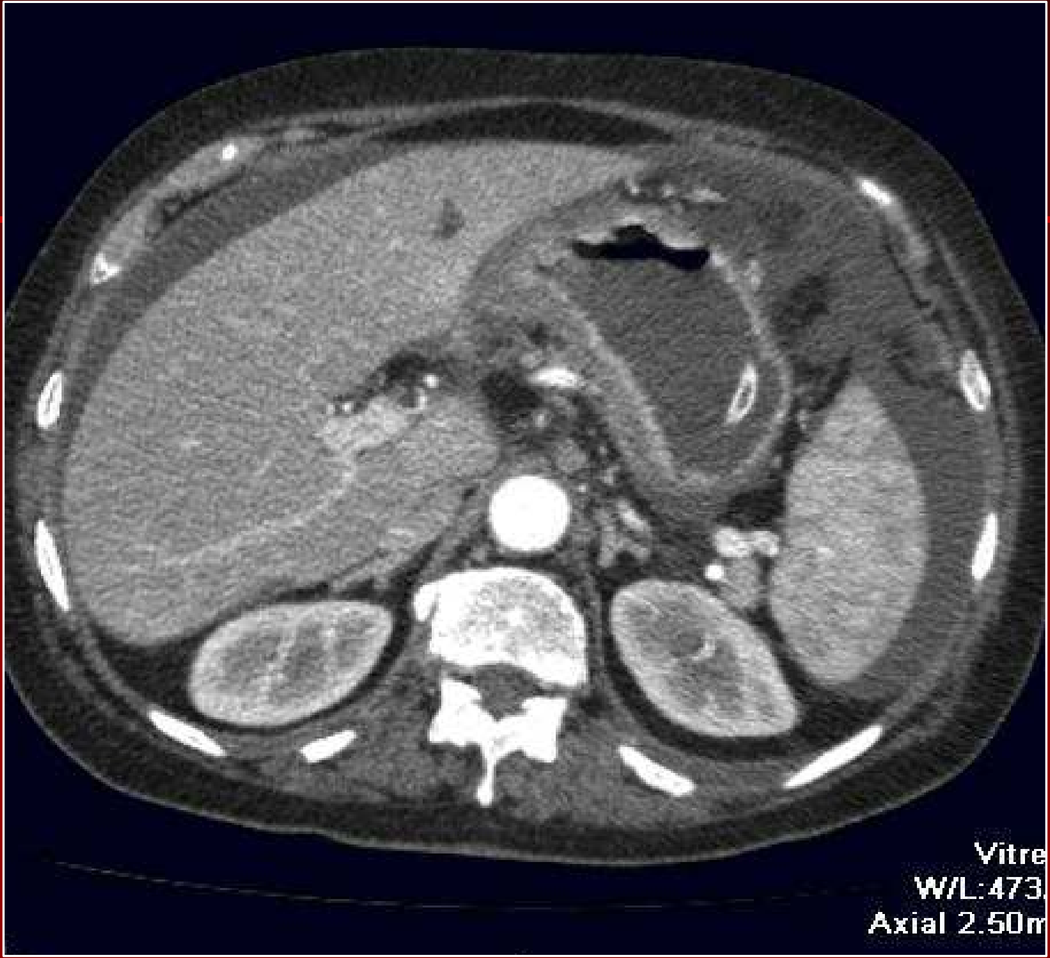
CAUSE DI ERRORI DIAGNOSTICI (Rx – TC)

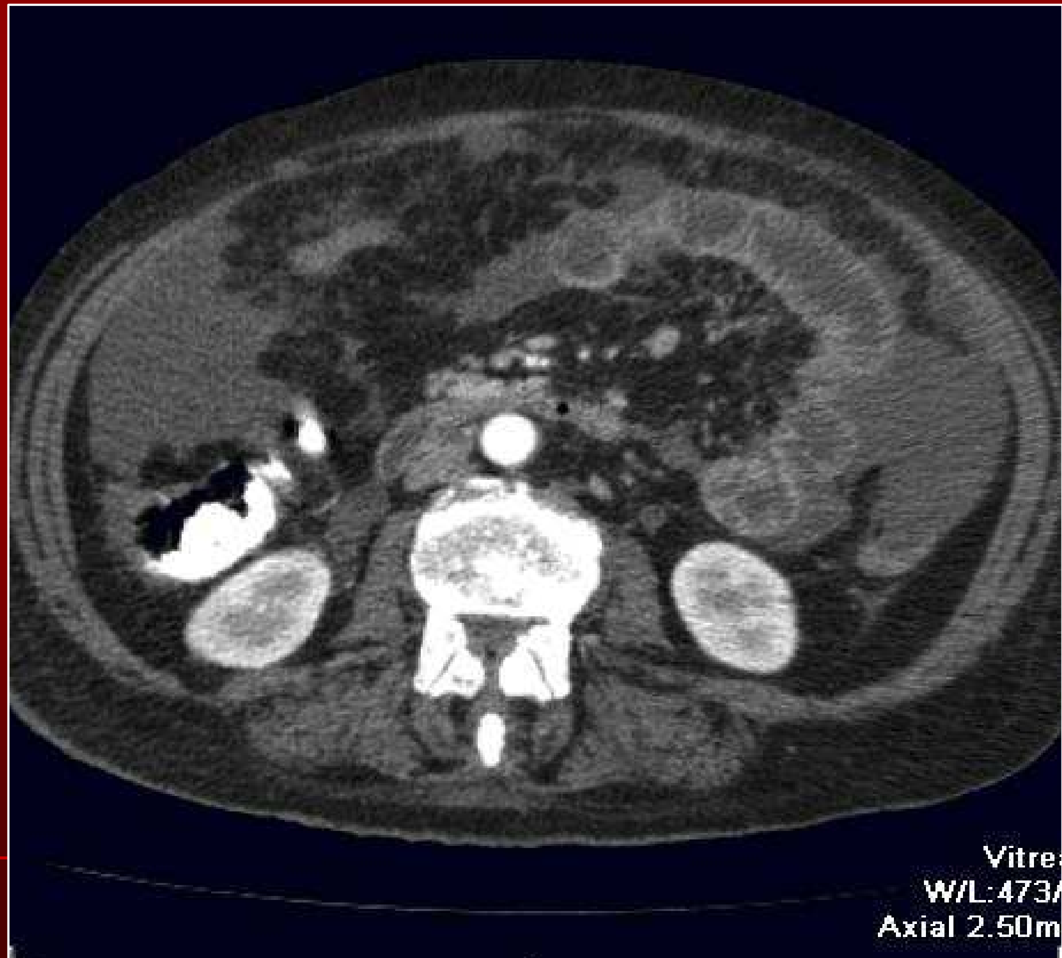
FALSI POSITIVI

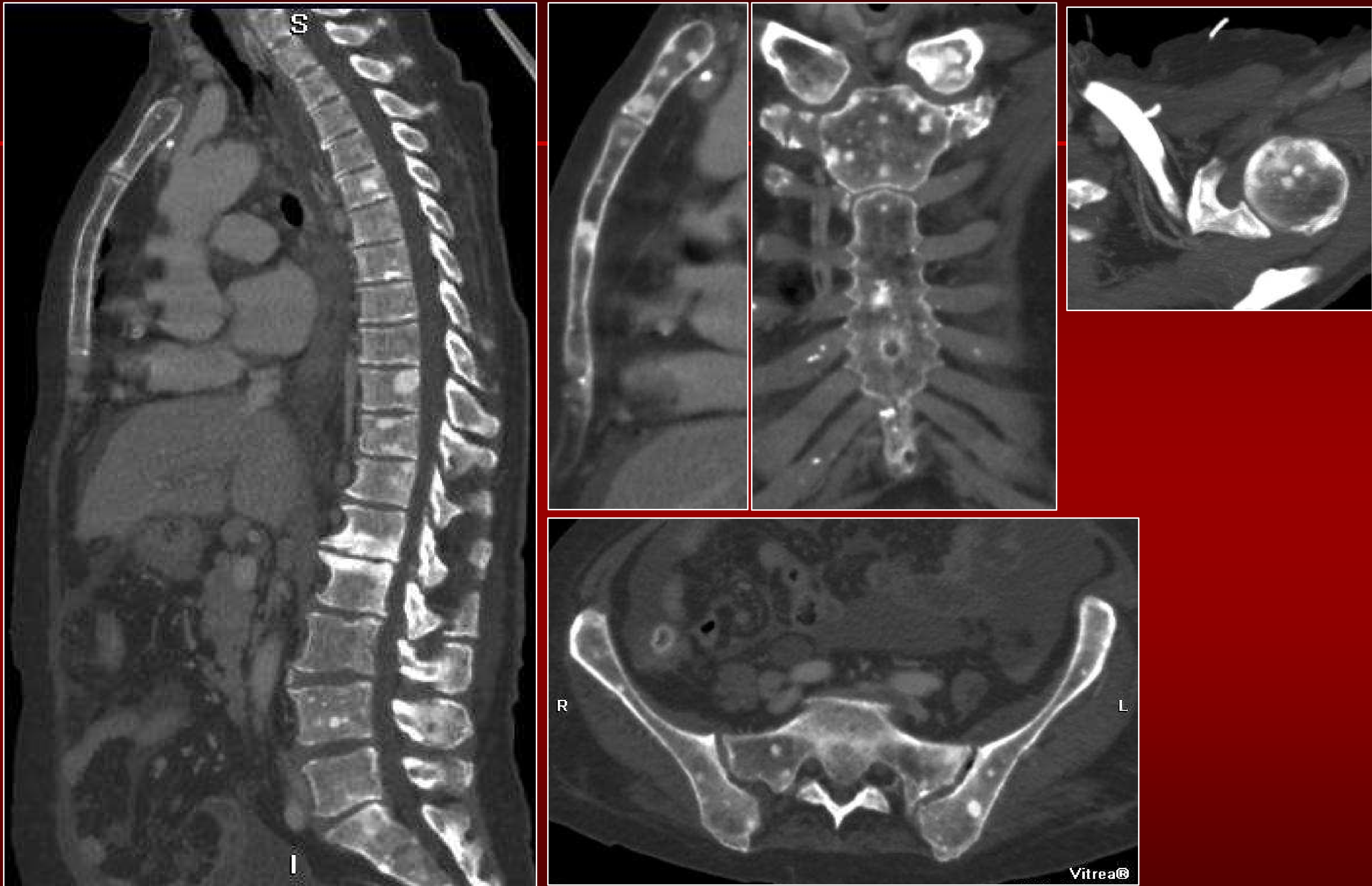
- Aree osteosclerosi
- Alterazioni artrosiche
- Osteoporosi
- Patologia infiammatoria
- Lesioni traumatiche

FALSI NEGATIVI

- Alterazioni artrosiche
- Non demineralizzazione
- Piccole lesioni
- Scarsa risoluzione di contrasto


Vitre
W/L:473
Axial 2.50m


Vitre
W/L:473
Axial 2.50m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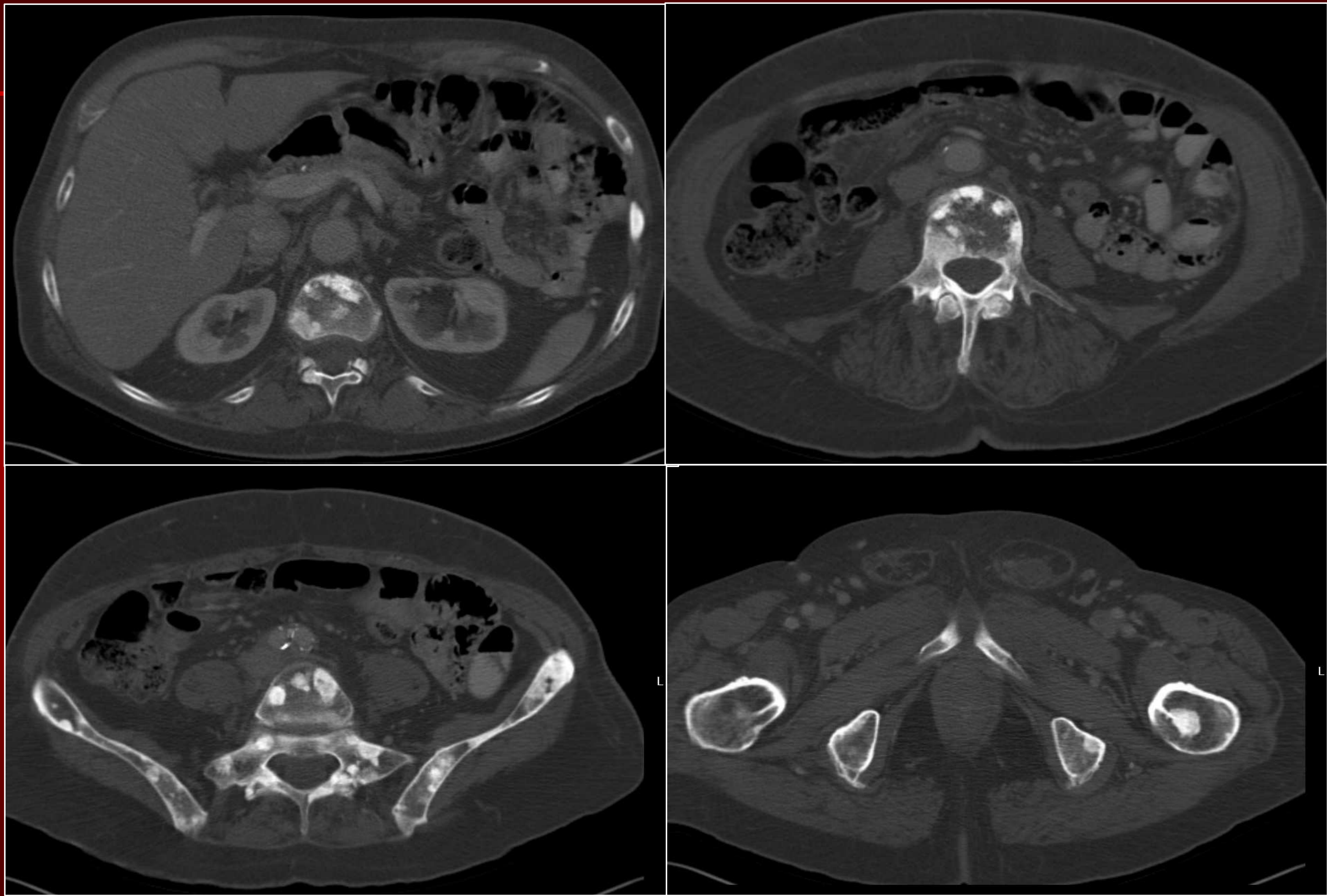
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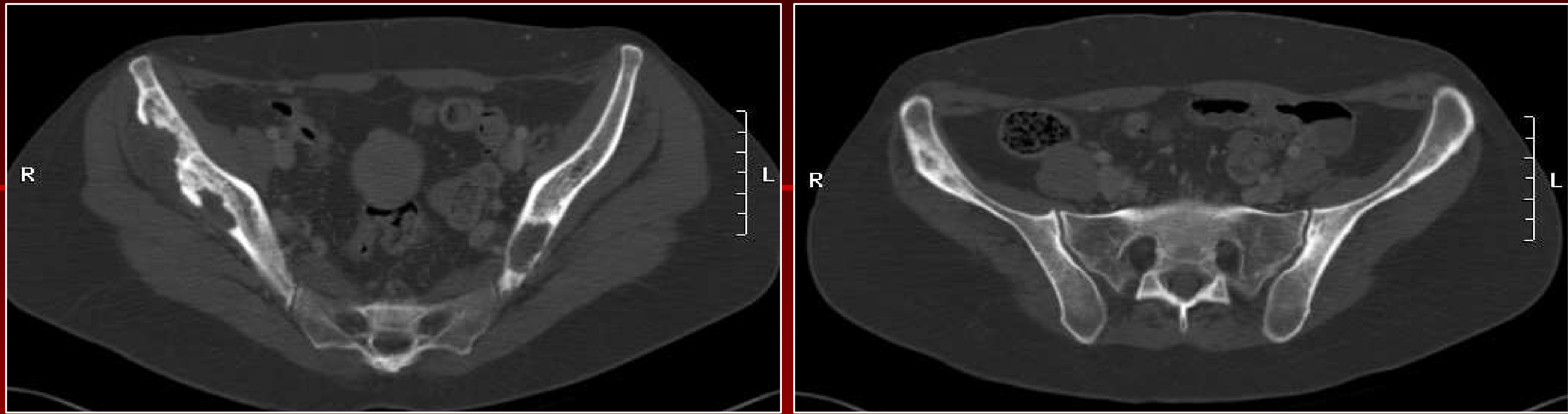

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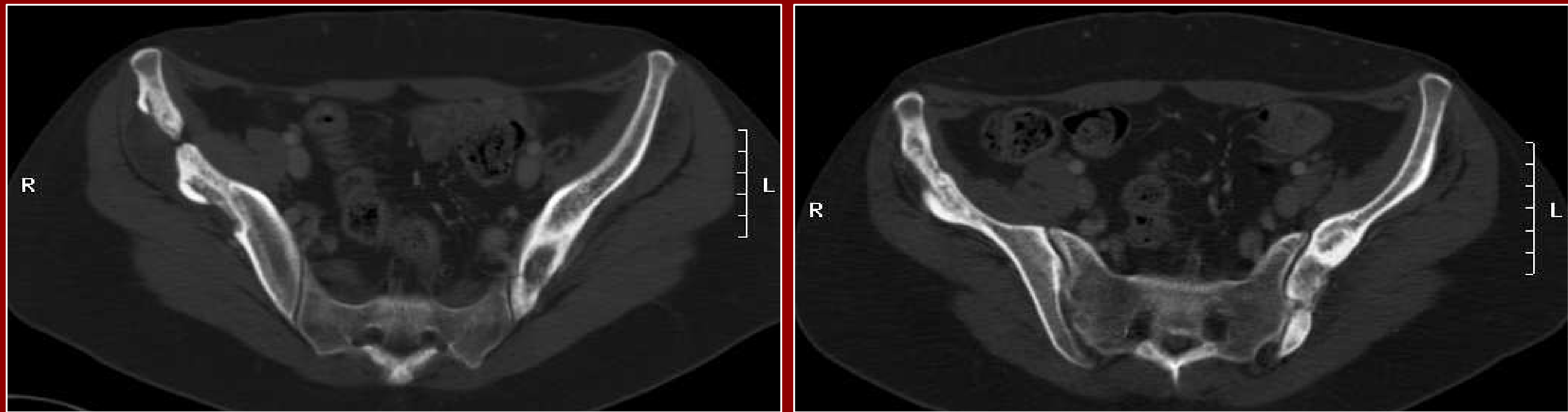

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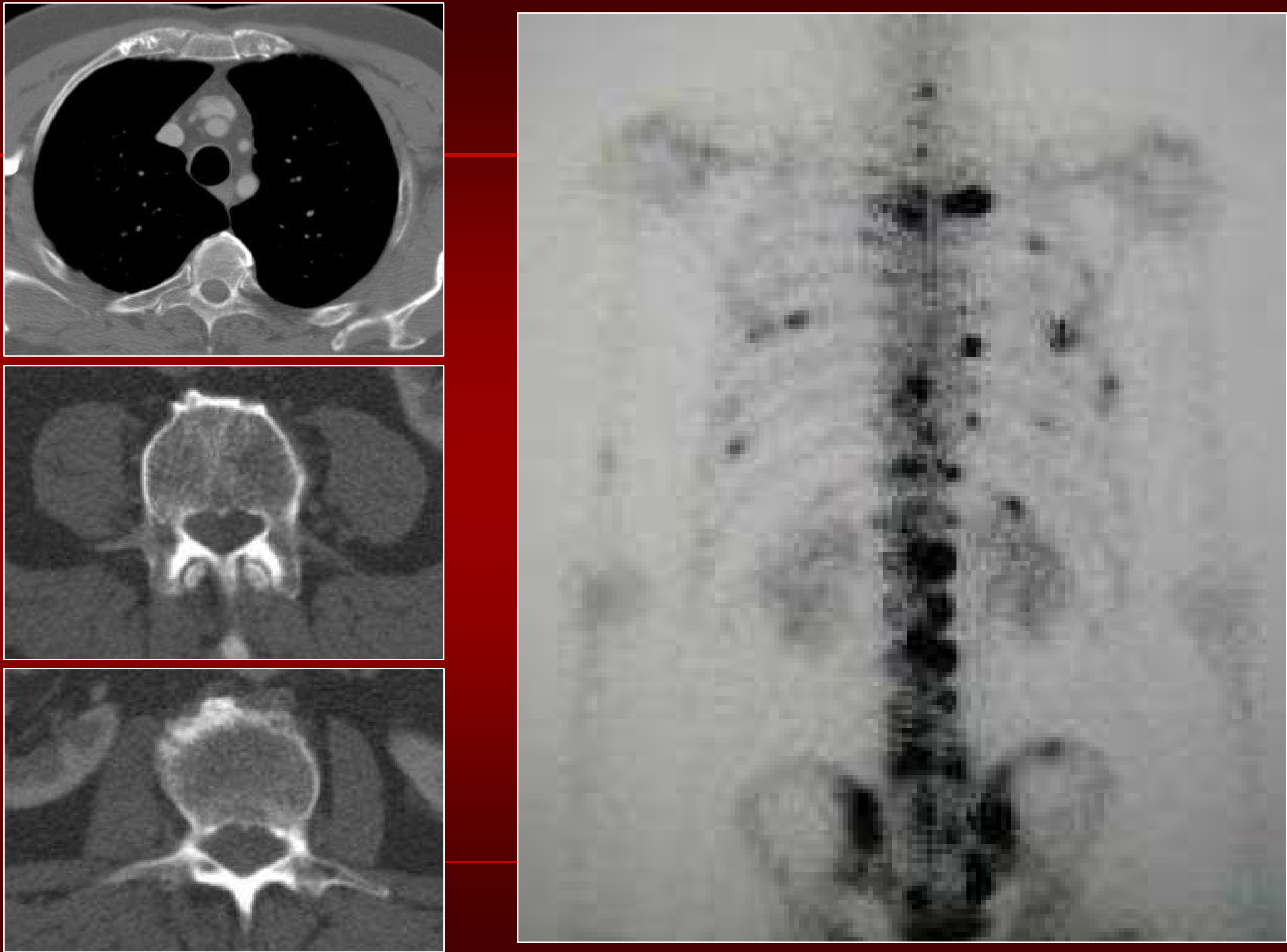


RISONANZA MAGNETICA – vantaggi

- Elevata risoluzione spaziale
- Elevata risoluzione di contrasto
- Non utilizzo di radiazioni ionizzanti
- Multiplanarietà
- Multiparametricità
- Alta sensibilità (93%) e specificità (97%)*

*EJR 2002; 43: 256-261

RISONANZA MAGNETICA – vantaggi

Consente un riconoscimento accurato delle alterazioni a carico del midollo osseo

↓

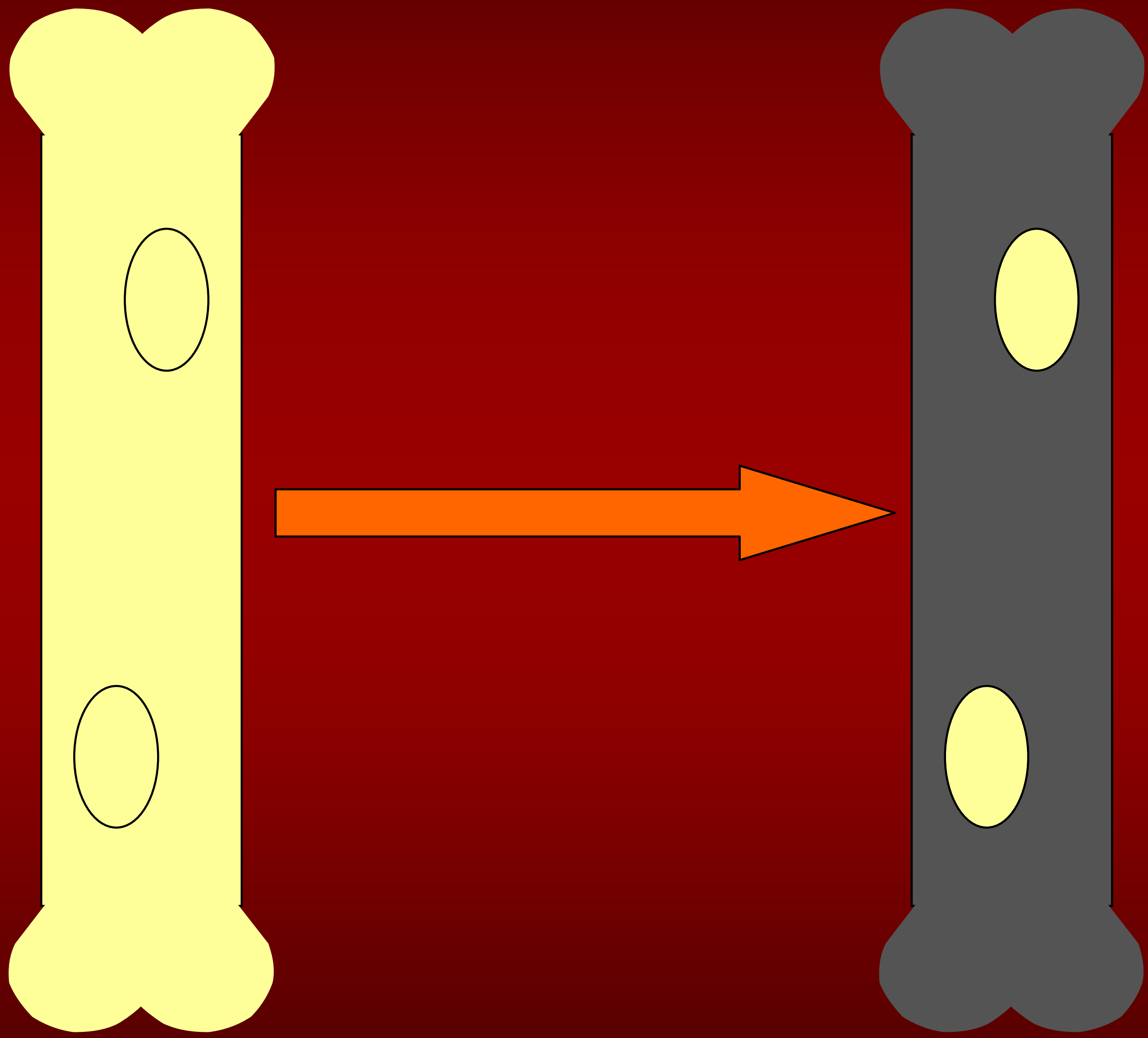
Sequenze con soppressione del grasso

- STIR
- SPAIR
- Fat Sat

*EJR 2002; 43: 256-261

EJR 2005; 55: 2-32

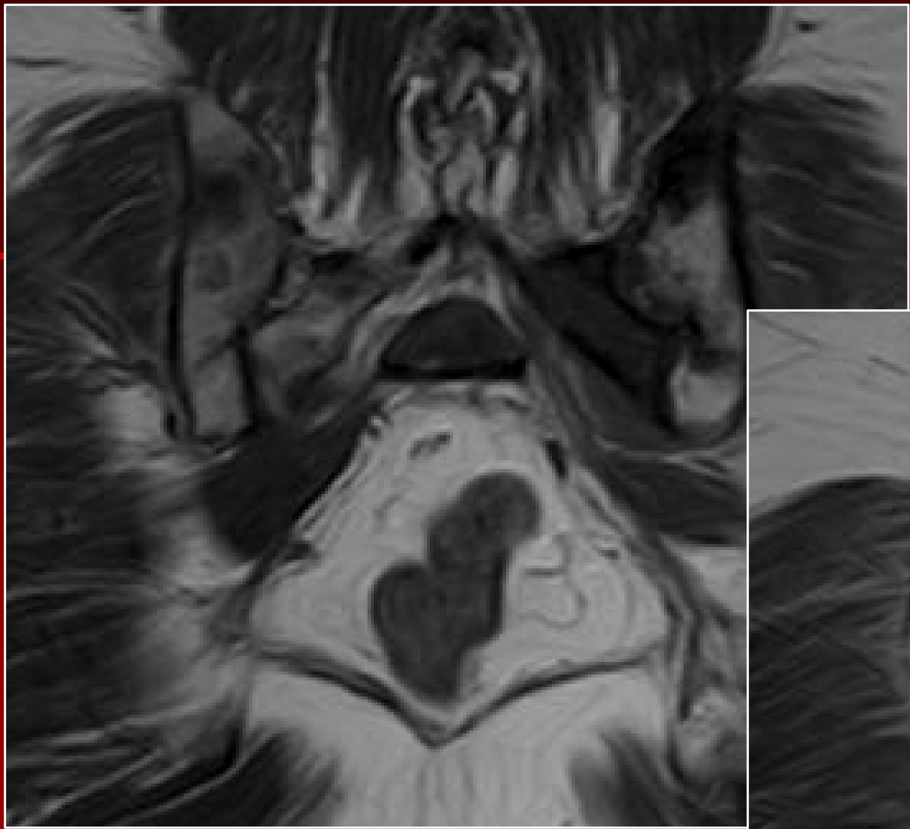
SEQUENZE CON SOPPRESSIONE DEL GRASSO

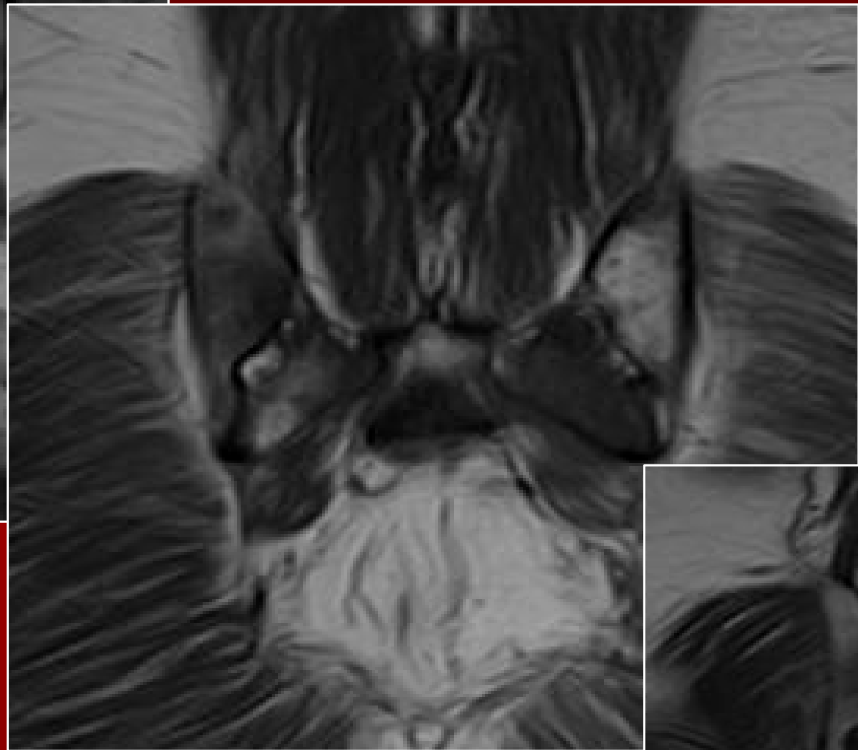


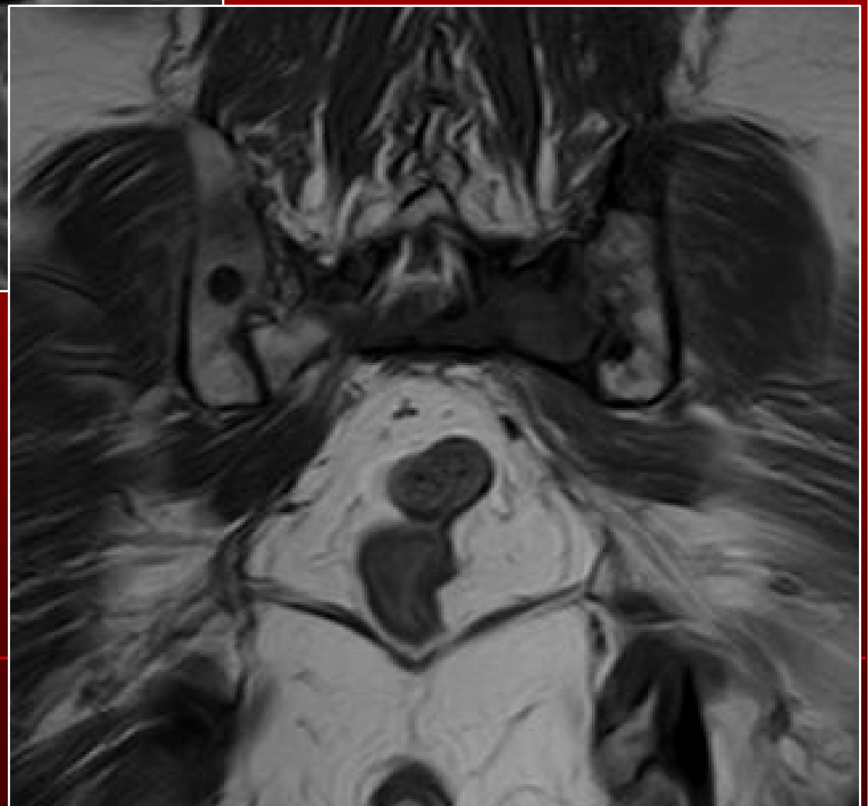
RISONANZA MAGNETICA – limiti (relativi)

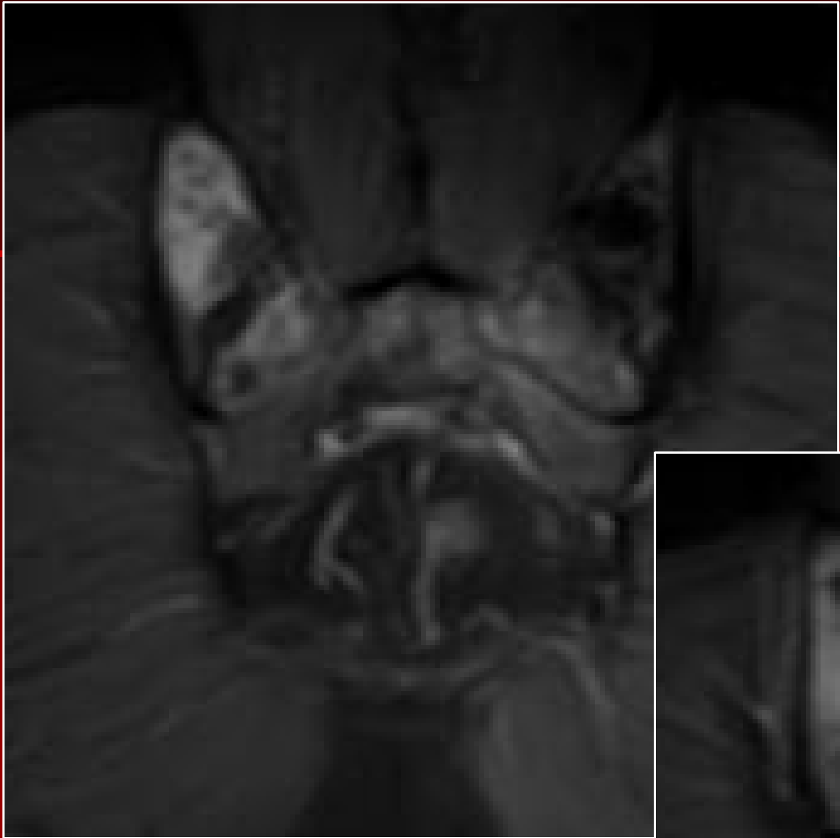
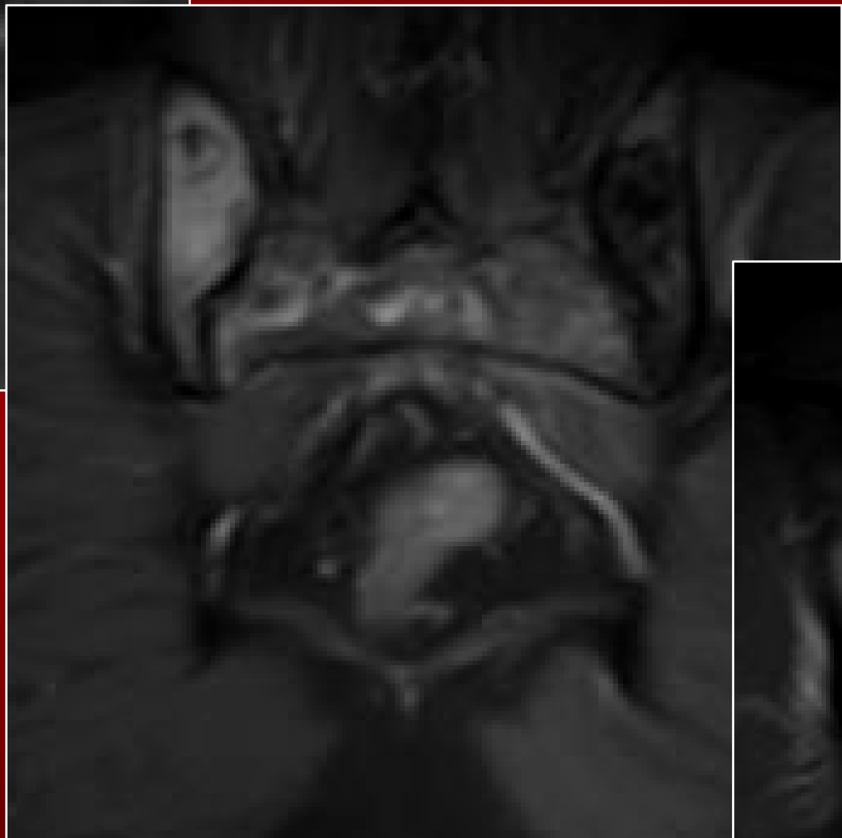
- Impossibilità di eseguire un esame total body
- Costi
- Scarso numero di installazioni

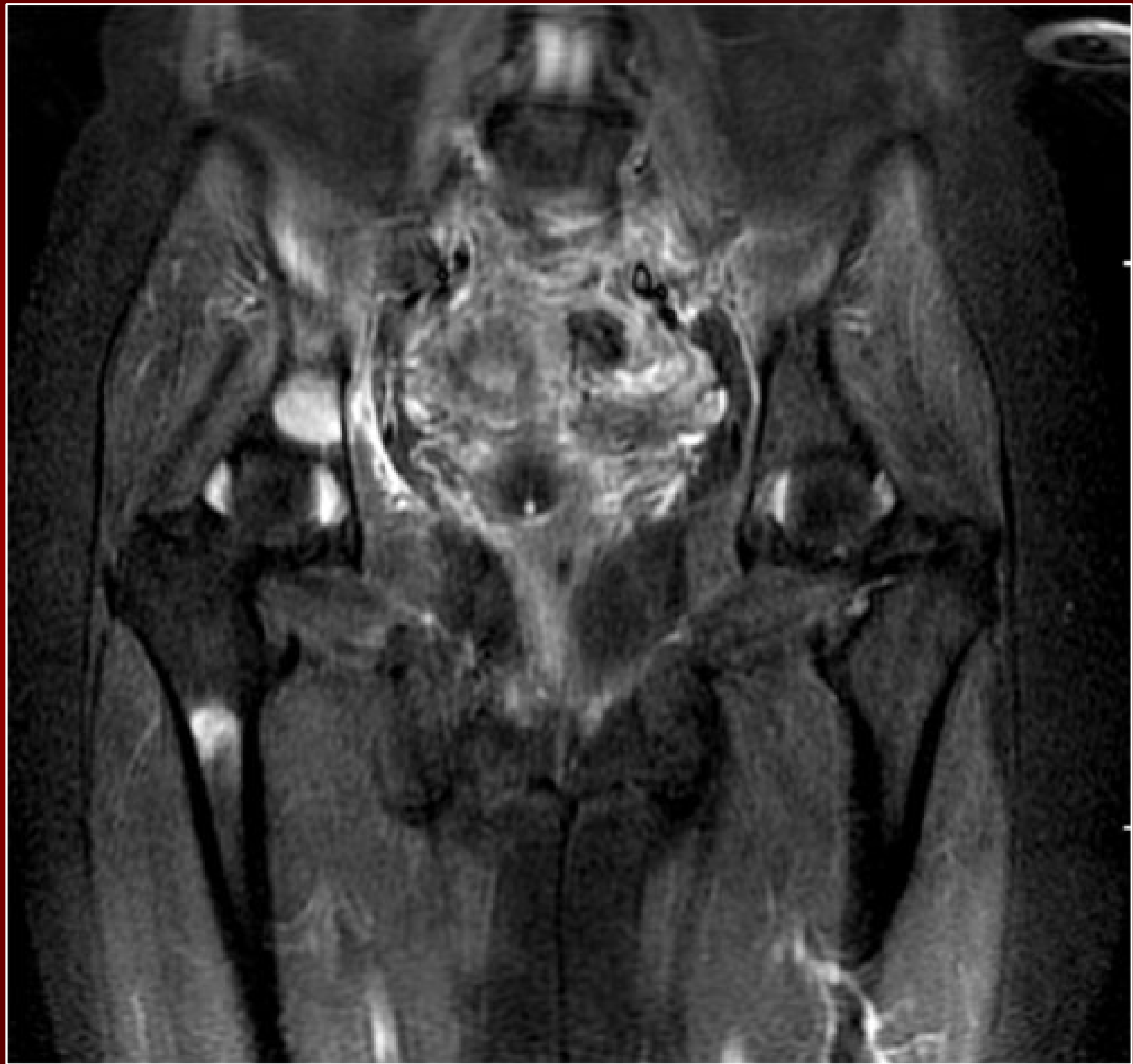
*EJR 2002; 43: 256-261

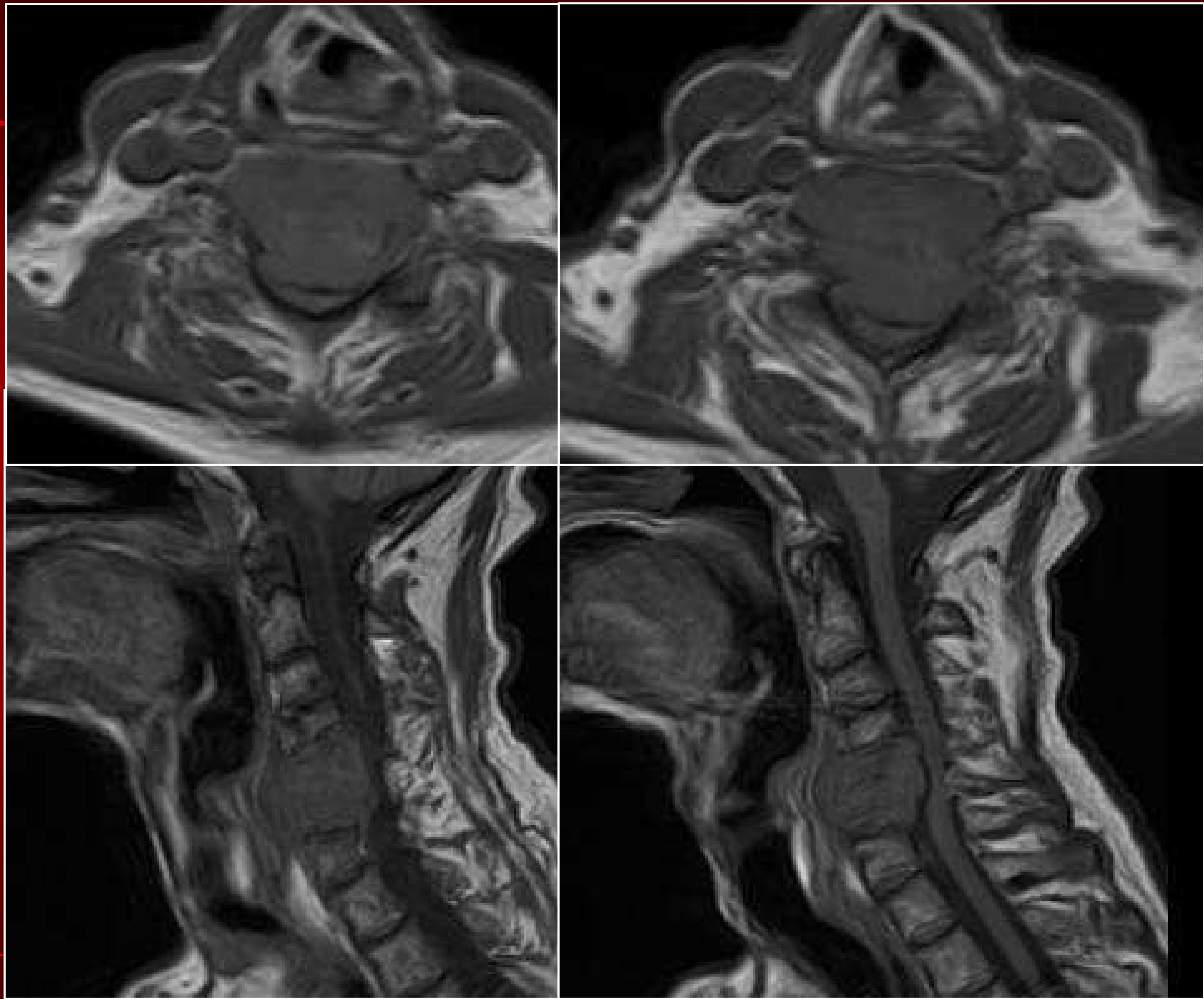


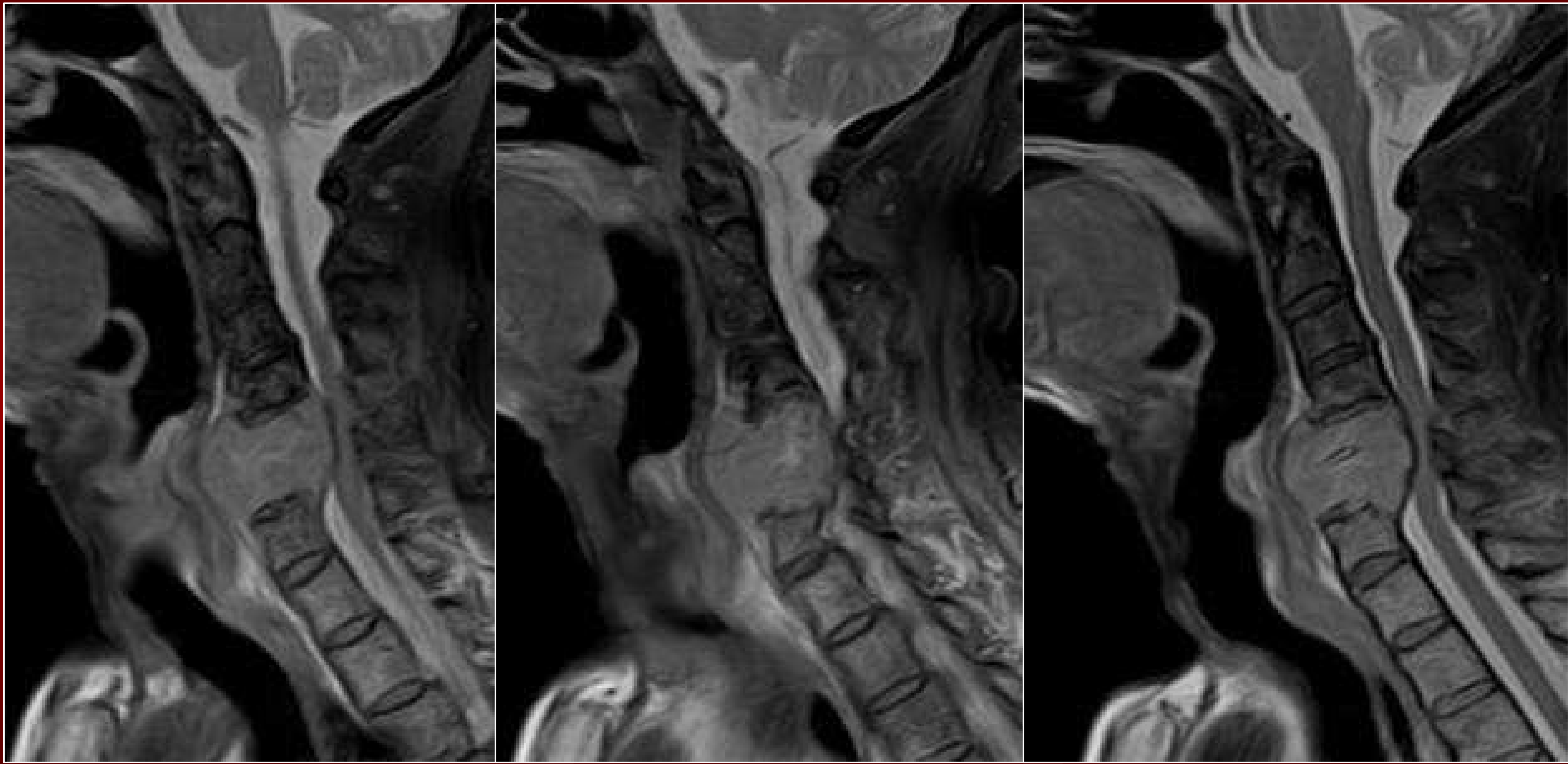


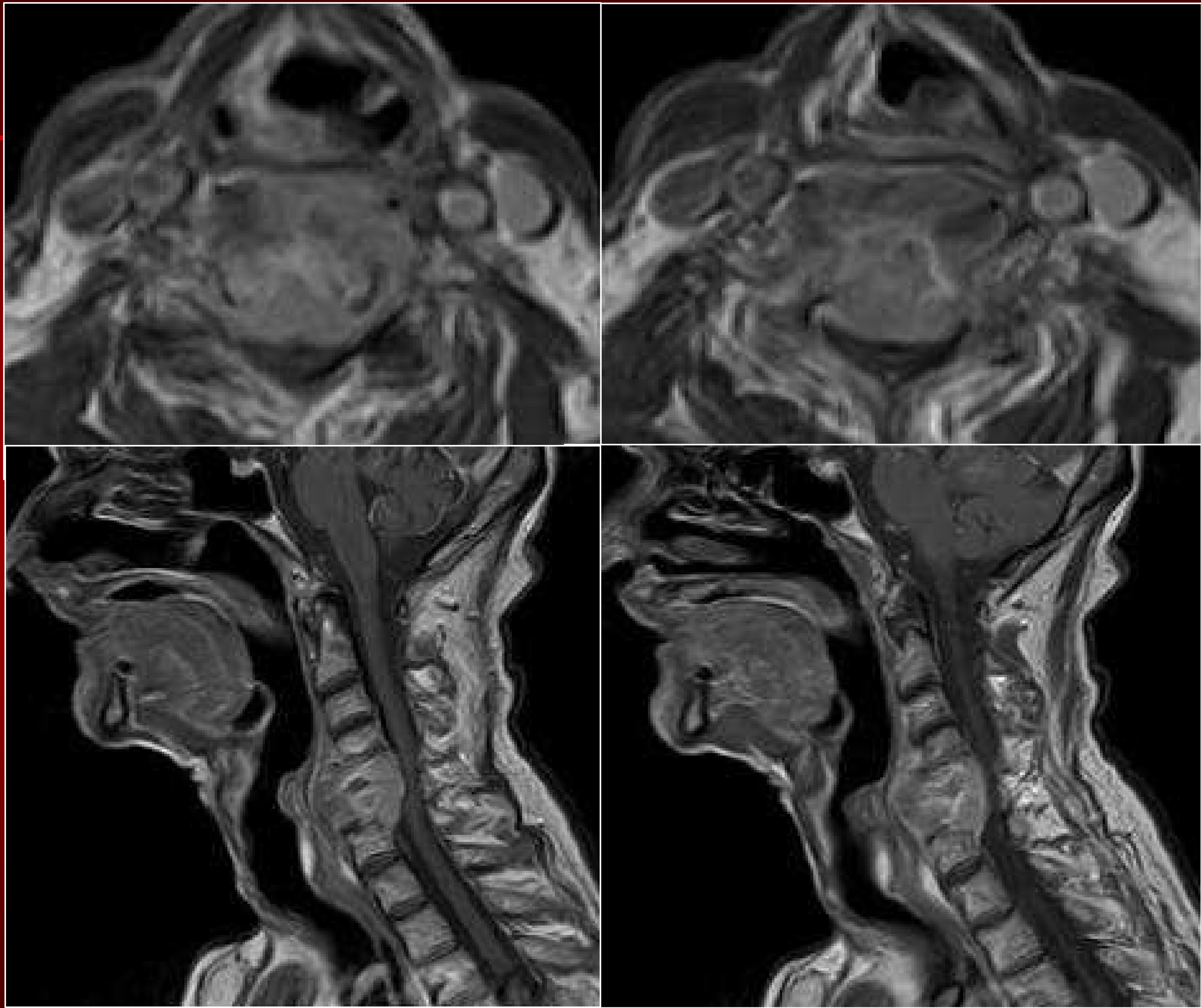








CAUSE DI ERRORI DIAGNOSTICI (RMN)

FALSI POSITIVI

- Edema osseo
- Patologia infiammatoria
- Lesioni traumatiche

FALSI NEGATIVI

- Lesioni fortemente sclerotiche
- Scansioni mirate

SCINTIGRAFIA OSSEA

- ALTA SENSIBILITA'
- ESPLORAZIONE TOTAL BODY
- NESSUNA TOSSICITA'
- BASSA IRRADIAZIONE
- MONITORAGGIO DELLA TERAPIA
- COSTO CONTENUTO

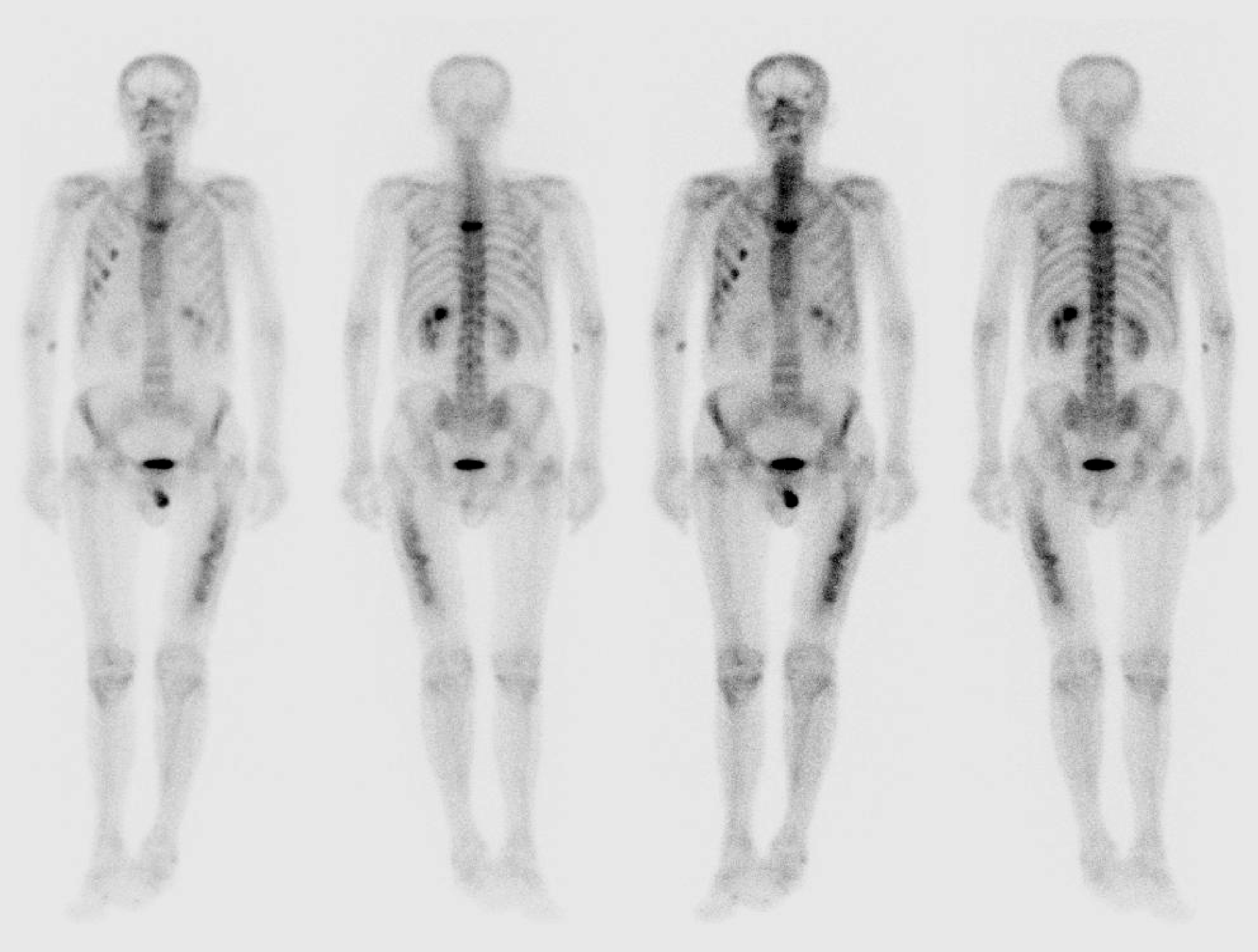
DOSIMETRIA: SCINTIGRAFIA OSSEA

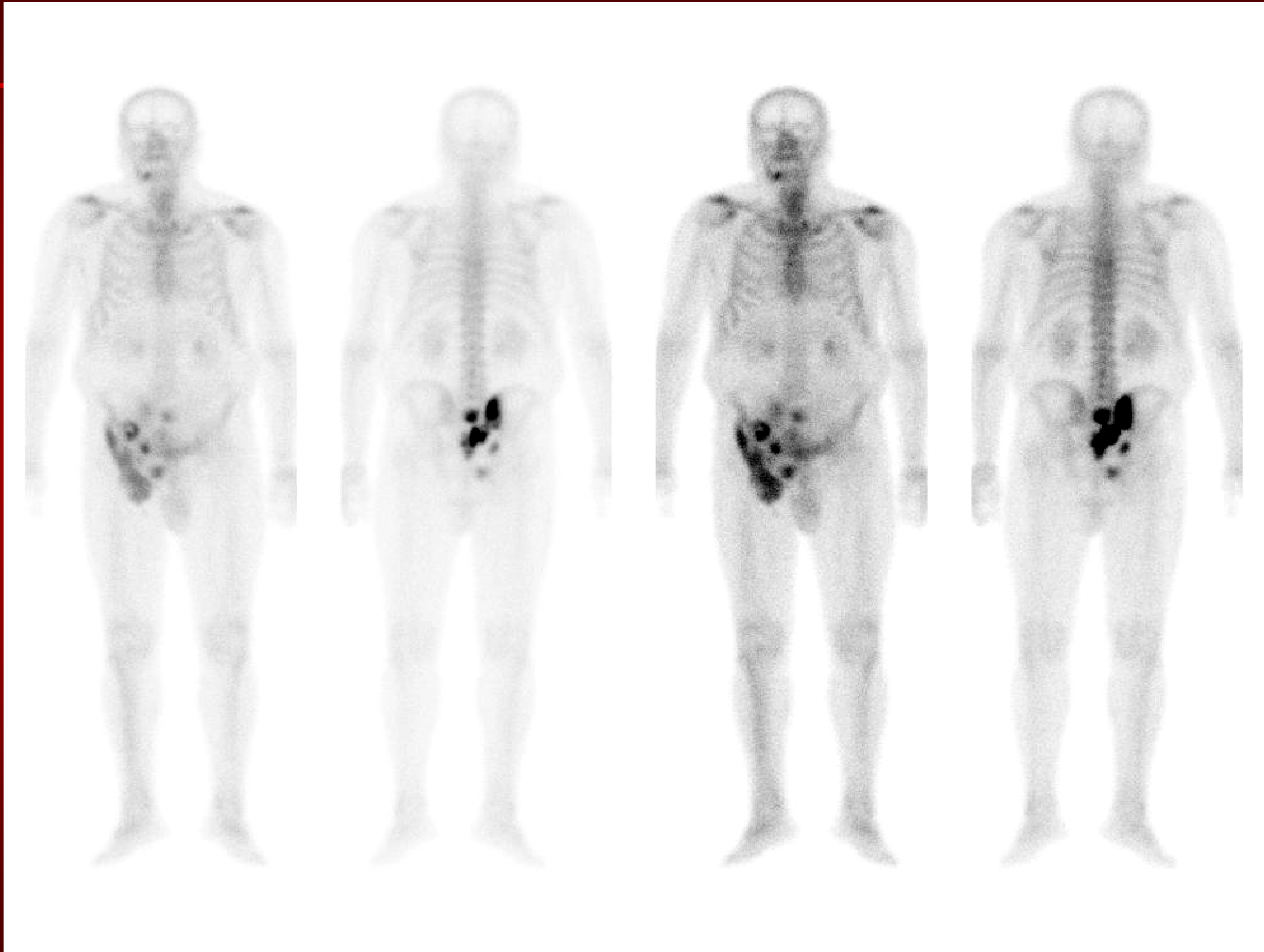
	Equivalente di dose efficace	Organo critico adulto mGy/MBq	…o osseo …Gy/MBq
99mTc-MDP	5,6 mSv	…	0,0096
99mTc-Nanocolloidi	2,5…	fegato:0,078	0,014

= 1 Rx Torace

CAUSE DI ERRORI DIAGNOSTICI (MN)

- Processi degenerativi
- Infiammatori
- Stress meccanici
- Osteolisi pura





Scintigrafia Planare

SPECT MULTI FOV

PET- (TC)

- Maggiore sensibilità, specificità ed accuratezza diagnostica rispetto alla scintigrafia
- Valutazione complessiva
  - Scheletro
  - Altri organi
- Costi elevati
- Scarsa disponibilità

PET- (TC)

The Detection of Bone Metastases in Patients with High-Risk Prostate Cancer: ^{99m}Tc-MDP Planar Bone Scintigraphy, Single- and Multi-Field-of-View SPECT, ^{18}F-Fluoride PET, and ^{18}F-Fluoride PET/CT

Einat Even-Sapir, MD, PhD[1,2]; Ur Metser, MD[1,2]; Eyal Mishani, PhD[3]; Gennady Lievshitz, MD[1]; Hedva Lerman, MD[1]; and Ilan Leibovitch, MD[2,4]

[1]Department of Nuclear Medicine, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel; [2]Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel; [3]Cyclotron Unit, Hadassah University Hospital, Jerusalem, Israel; and [4]Department of Urology, Meir Medical Center, Kfar Saba, Israel

The aim of this study was to compare the detection of bone metastases by ^{99m}Tc-methylene diphosphonate (^{99m}Tc-MDP) planar bone scintigraphy (BS), SPECT, ^{18}F-Fluoride PET, and ^{18}F-Fluoride PET/CT in patients with high-risk prostate cancer. **Methods:** In a prospective study, BS and ^{18}F-Fluoride PET/CT were performed on the same day in 44 patients with high-risk prostate cancer. In 20 of the latter patients planar BS was followed by single field-of-view (FOV) SPECT and in 24 patients by multi-FOV SPECT of the axial skeleton. Lesions were interpreted separately on each of the 4 modalities as normal, benign, equivocal, or malignant. **Results:** In patient−based analysis, 23 patients had skeletal metastatic spread (52%) and 21 did not. Categorizing equivocal and malignant interpretation as sugges-

0.001). **Conclusion:** ^{18}F-Fluoride PET/CT is a highly sensitive and specific modality for detection of bone metastases in patients with high-risk prostate cancer. It is more specific than ^{18}F-Fluoride PET alone and more sensitive and specific than planar and SPECT BS. Detection of bone metastases is improved by SPECT compared with planar BS and by ^{18}F-Fluoride PET compared with SPECT. This added value of ^{18}F-Fluoride PET/CT may beneficially impact the clinical management of patients with high-risk prostate cancer.

Key Words: PET-CT; ^{18}F-Fluoride; SPECT; bone metastases; prostate cancer

J Nucl Med 2006; 47:287–297

TABLE 3

Detection of Bone Metastases in 24 Study Patients Who Had Multi-FOV Axial-Body SPECT

	Final diagnosis									
	Spread of metastases (n = 13)			No metastases (n = 11)			Interpretation*			
Modality	M	E	B/N	M	E	B/N	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Planar BS	6	3	4	0	4	7	69 (46)	64 (100)	69 (100)	64 (61)
SPECT†	6	6	1	0	2	9	92 (46)	82 (100)	86 (100)	90 (61)
^{18}F-Fluoride PET	6	7	0	0	2	9	100 (46)	82 (100)	87 (100)	100 (61)
^{18}F-Fluoride PET/CT	11	2	0	0	0	11	100 (85)	100 (100)	100 (100)	100 (85)

*Analysis considering equivocal results as positive for malignancy. In parentheses, analysis considering equivocal results as negative for malignancy.

†Multi-FOV SPECT composed of 3 or 4 FOVs covering the axial skeleton.

M = malignant; E = equivocal; B/N = benign or normal.

TABLE 6

Lesion-Based Analysis of 112 Lesions with Increased ^{18}F-Fluoride for Which SPECT Was Available

	Final diagnosis									
	Metastases (n = 41)			No metastases (n = 71)			Interpretation*			
Modality	M	E	B/N	M	E	B/N	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Planar BS	10	6	25	2	13	56	39 (24)	79 (97)	52 (83)	64 (69)
SPECT	10	19	12	3	8	60	71 (24)	85 (96)	73 (77)	83 (69)
^{18}F-Fluoride PET	14	27	0	2	8	61	100 (34)	86 (96)	80 (88)	100 (72)
^{18}F-Fluoride PET/CT	32	9	0	0	0	71	100 (78)	100 (100)	100 (100)	100 (89)

*In results analysis, normal and benign interpretation was considered nonmalignant. Equivocal and malignant interpretation was considered malignant. In parentheses, results analysis with normal, benign, and equivocal interpretation being considered nonmalignant.

M = malignant; E = equivocal; B/N = benign or normal.

Scintigrafia ossea vs PET vs RMN

	BS-SPECT	PET-TC	RMN
Sensibilità	74-80	96-100	92-95
Specificità	75-90	96-97	95-97
Accuratezza	77-80	95-97	96-98

Eur J Nucl Med 2000; 27: 1305
Int Cong Ser 2005; 1264: 239
EJR 2002; 43: 256-261

Radiology

CT Appearance of Bone Metastases Detected with FDG PET as Part of the Same PET/CT Examination[1]

Yuji Nakamoto, MD, PhD
Christian Cohade, MD
Mitsuaki Tatsumi, MD, PhD
Dima Hammoud, MD
Richard L. Wahl, MD

Published online
10.1148/radiol.2372031994
Radiology 2005; 237:627–634

Abbreviations:
FDG = fluorine 18 fluorodeoxyglucose
SUV = standardized uptake value

[1] From the Division of Nuclear Medicine, Johns Hopkins School of Medicine, 601 N Caroline St, Room 3223A, Baltimore, MD 21287-0817. Received December 8, 2003; revision requested February 12, 2004; final revision received December 9; accepted January 26, 2005. Address correspondence to R.L.W.

Authors stated no financial relationship to disclose.

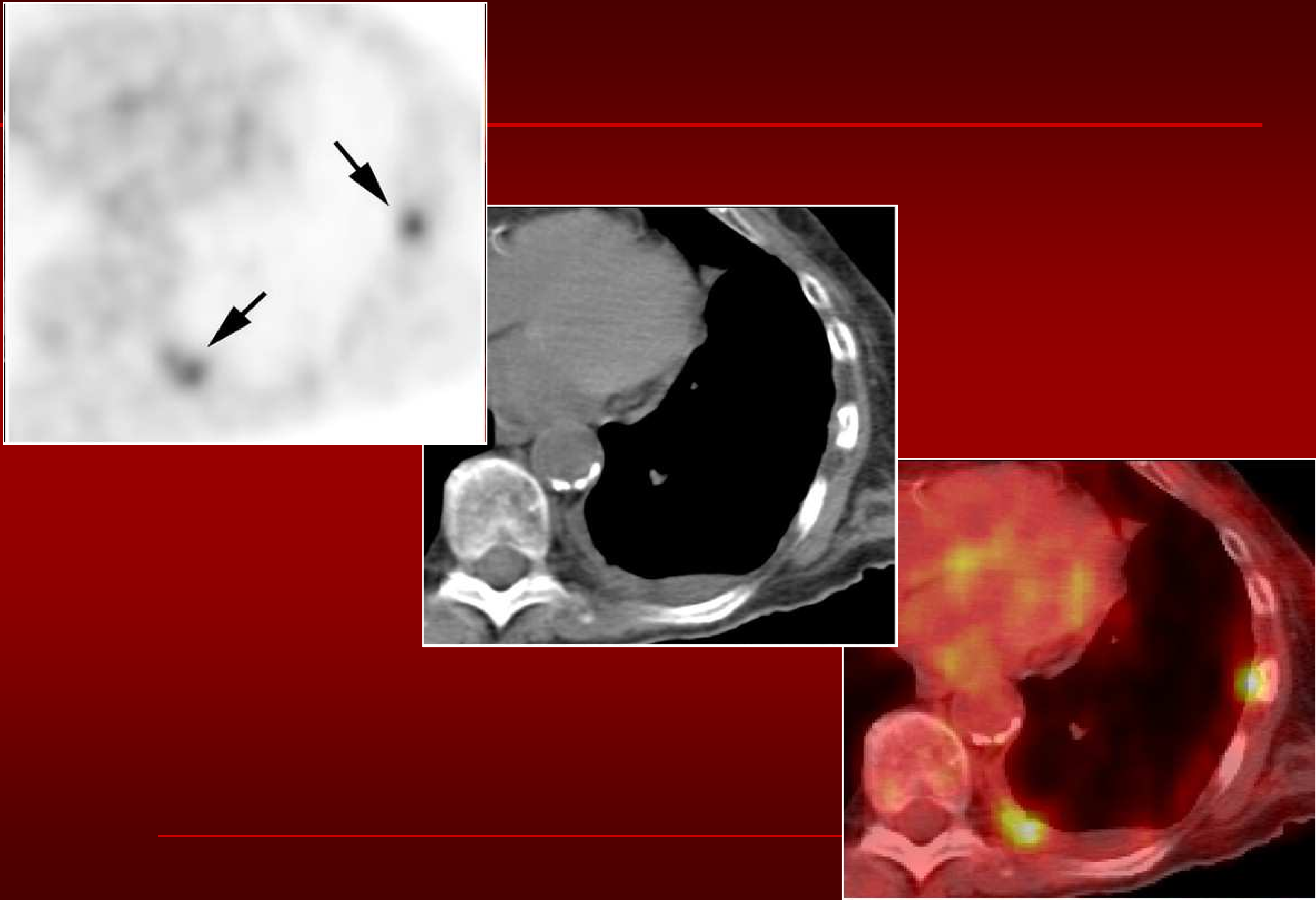
PURPOSE: To retrospectively evaluate lesion findings at computed tomography (CT) performed as part of a combined positron emission tomography (PET)/CT examination in patients suspected of having metastatic bone lesions—lesions that were detected with fluorine 18 fluorodeoxyglucose (FDG) PET as part of the same examination—and to correlate the CT and FDG PET findings.

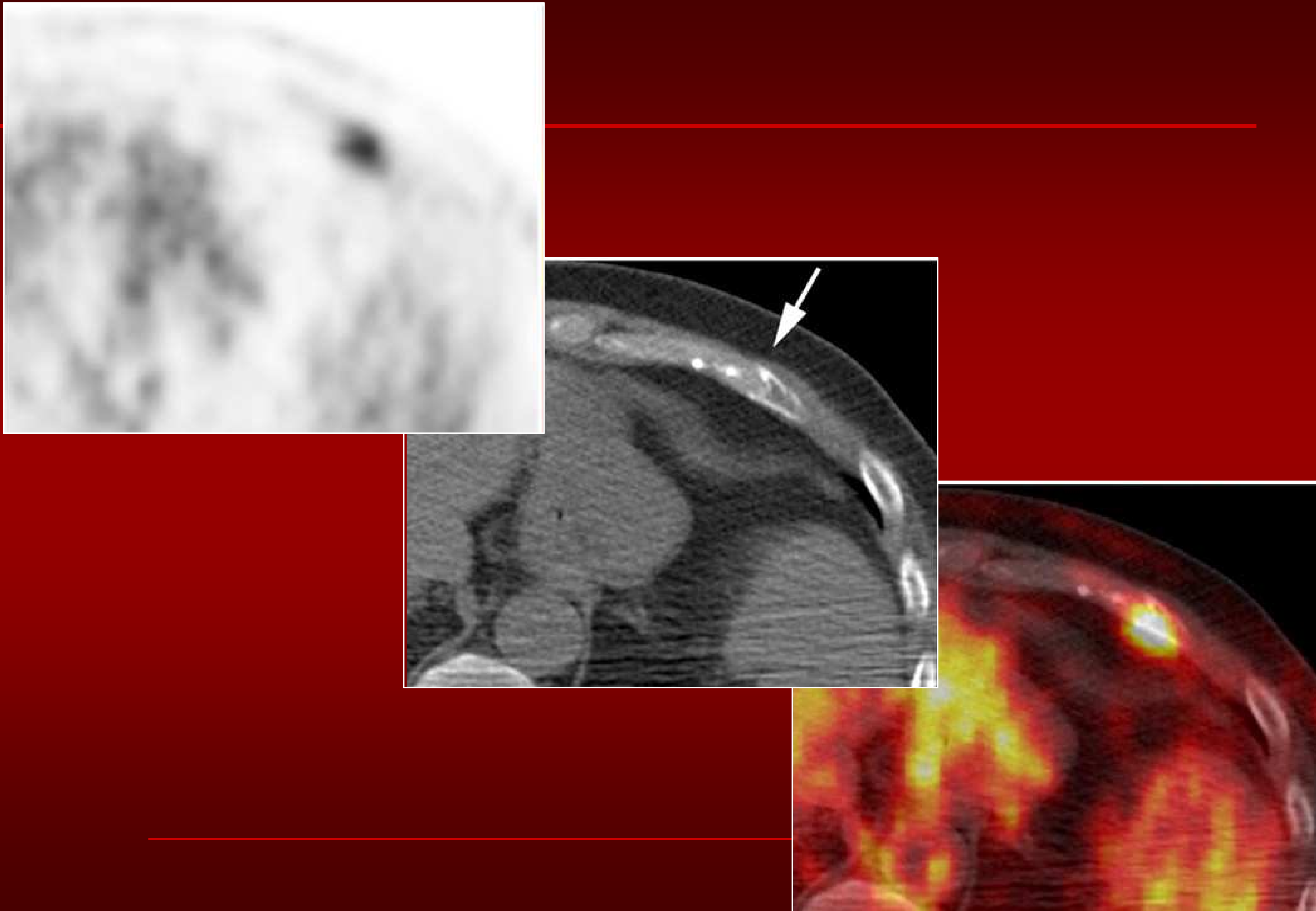
MATERIALS AND METHODS: This HIPAA-compliant study had institutional review board approval, and the need for patient informed consent was waived. Three hundred fifty-nine consecutive patients (191 male patients, 168 female patients; mean age, 56.9 years; age range, 8–92 years) underwent PET/CT. PET images were first reviewed by nuclear medicine physicians who had no clinical information regarding the presence or absence of bone metastasis by using a five-point grading system (0, a lesion was definitely negative for metastasis; 1, a lesion was probably negative; 2, a lesion was equivocal; 3, a lesion was probably positive; and 4, a lesion was definitely positive). For lesions assigned a grade of 3 or 4 at PET, CT characteristics such as the presence or absence of morphologic changes or accompanying findings (including bone destruction) were assessed by radiologists on the CT images obtained during the same imaging session.

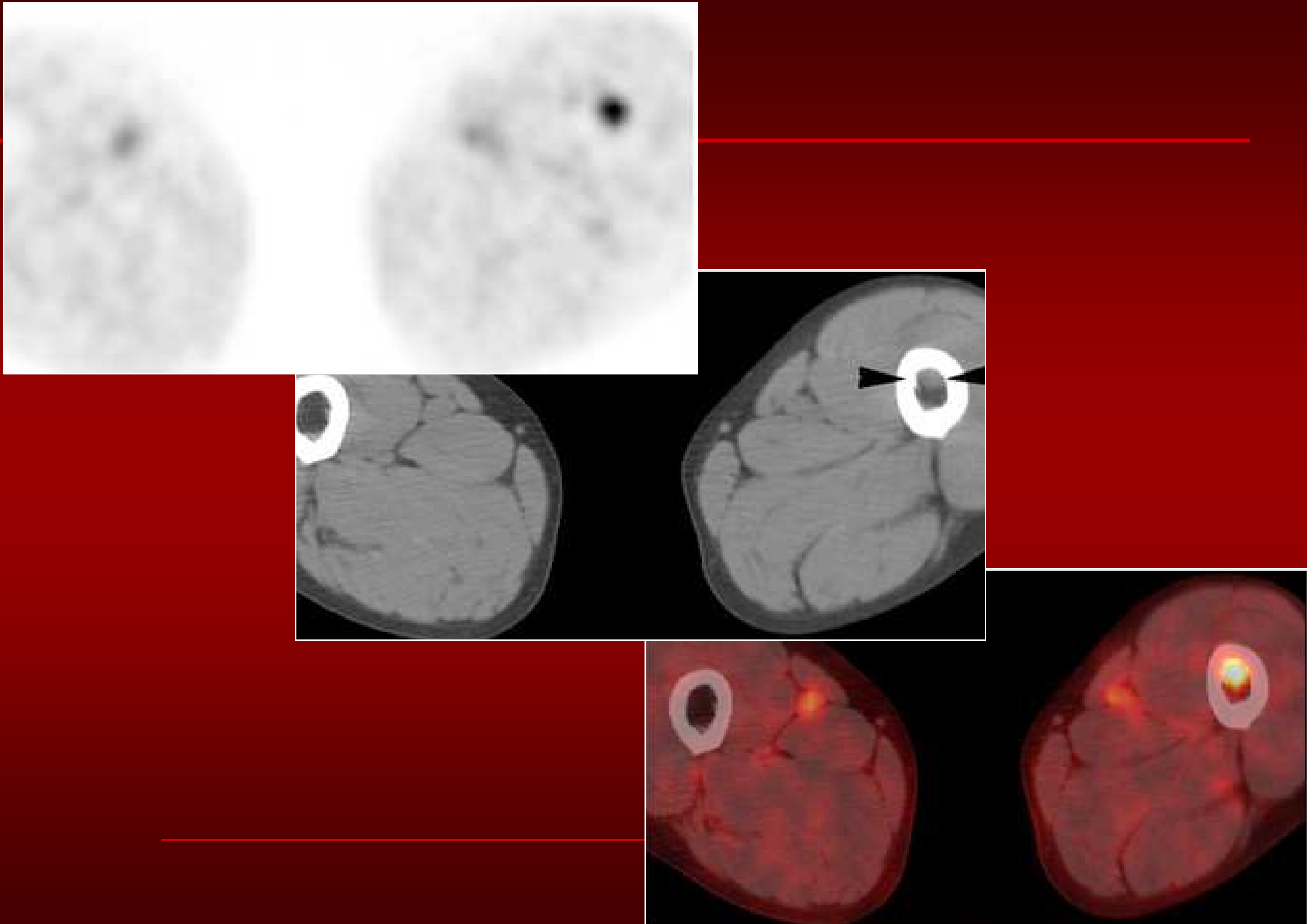
RESULTS: One hundred seventy-nine lesions in 55 patients were considered to be probable or definite bone metastases at PET. One hundred thirty-three of these lesions in 33 patients were clinically confirmed to be bone metastases at follow-up and/or histopathologic examination. CT revealed osteolytic changes in 41 (31%) and osteoblastic changes in 21 (16%) of the 133 lesions, but no or nonspecific changes were seen at CT in 49 (37%) and 22 lesions (17%), respectively. Of the 179 lesions suspected at PET, 46 ultimately proved to be nonosseous or false-positive for bone metastasis. Of these 46 lesions, 38 were not located in the bone but in adjacent tissues such as the pleura.

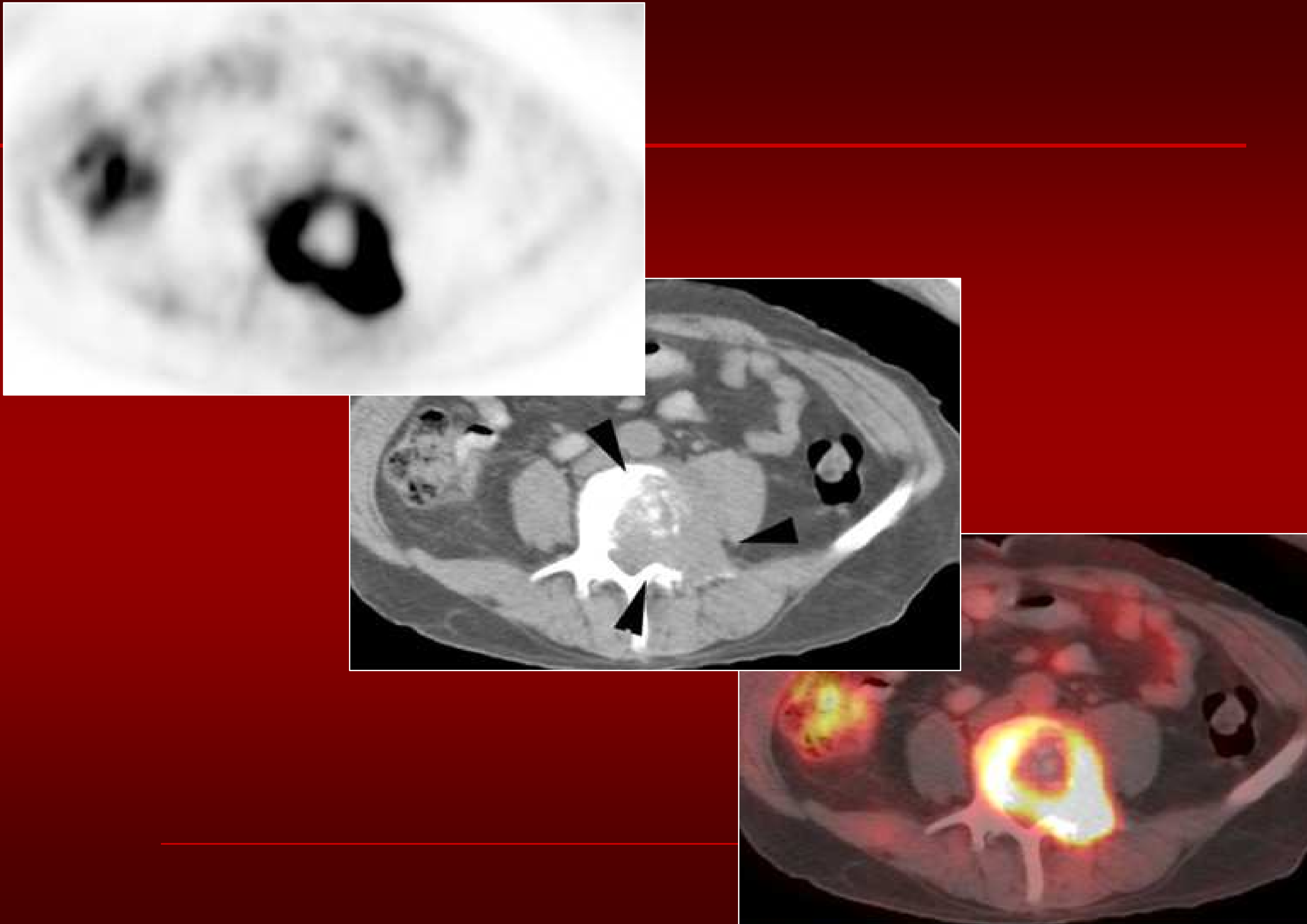
CONCLUSION: CT images obtained as part of PET/CT scanning were useful in yielding the precise location of bone lesions and thus helping avoid misdiagnosis of bone metastasis; however, CT revealed morphologic changes in only half of the lesions assigned a grade of 3 or 4 at PET.

Author contributions:









RICERCA METASTASI OSSEE – stadiazione

- Rx scheletro in toto

D.Lgs 187/2000

- **Scintigrafia ossea (+ SPECT)**
- **Markers serici**
- **Clinica**

Integrazione diagnostica

- Studio di lesioni dubbie
- Maggior dettaglio anatomico
- Studio di lesioni vertebrali (specie se con coesistente danno neurologico)

↓

1. **RMN**
2. **TC**

FOLLOW-UP

- FORME DIFFUSE — Scintigrafia
- FORME FOCALI — RMN – TC

Prospettive future

RadioGraphics 2004

Fast STIR Whole-Body MR Imaging in Children[1]

Christian J. Kellenberger, MD • Monica Epelman, MD • Stephen F. Miller, MD • Paul S. Babyn, MD

Fast spin-echo short inversion time inversion-recovery (STIR) whole-body magnetic resonance (MR) imaging is an evolving technique that allows imaging of the entire body in a reasonable time. Its wide availability and lack of radiation exposure makes this method appealing for the evaluation of children. Since 2001, the authors conducted 140 pe-

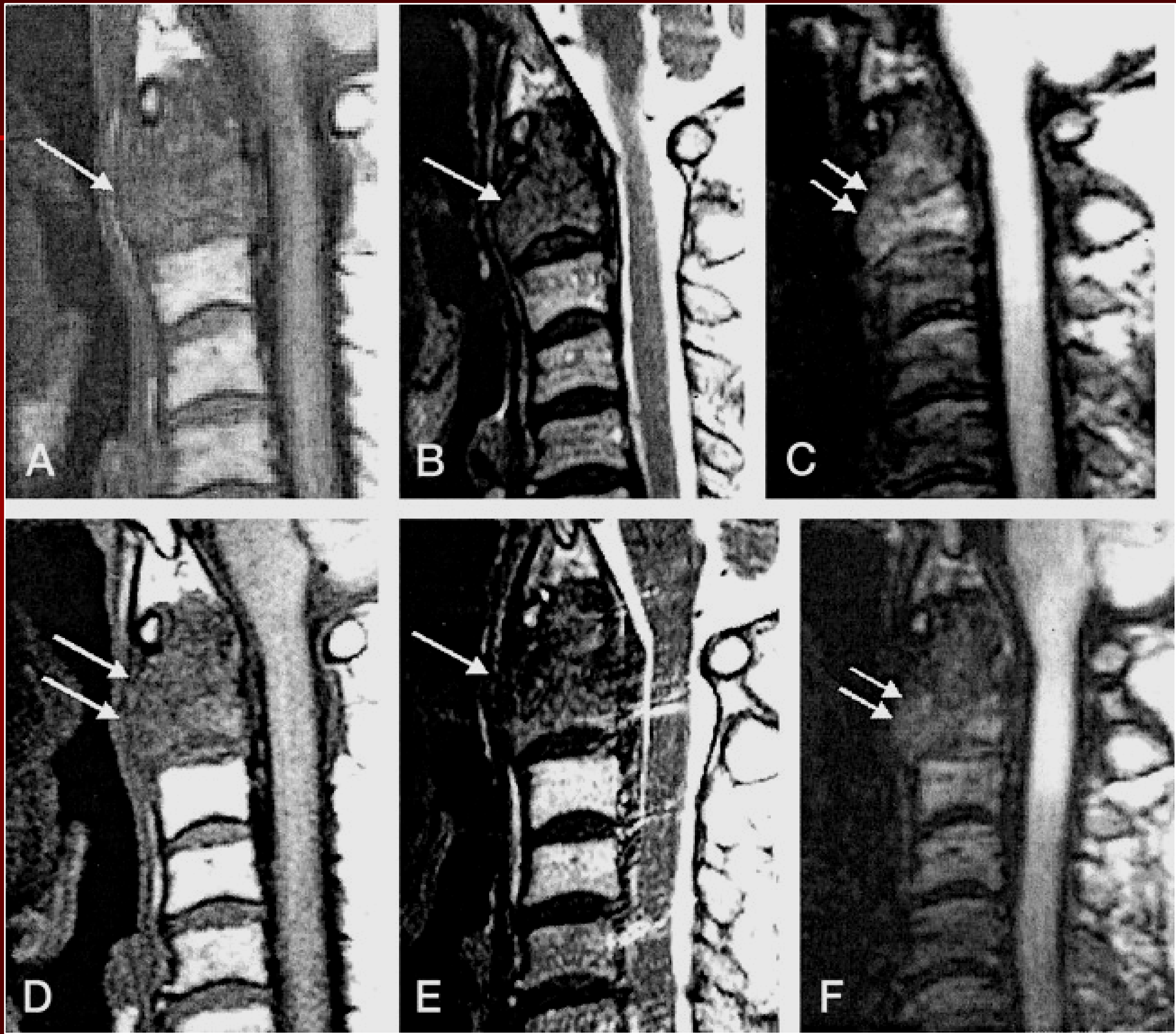
Prospettive future

AJNR Am J Neuroradiol 23:906–912, June/July 2002

Diffusion-Weighted MR Imaging of Metastatic Disease of the Spine: Assessment of Response to Therapy

Woo Mok Byun, Sei One Shin, Yongmin Chang, Sang Jin Lee, Jurgen Finsterbusch, and Jens Frahm

BACKGROUND AND PURPOSE: **In cases of metastatic disease of the spine, monitoring the response to medical therapy with plain radiography, bone scanning, and conventional spin-echo sequence MR imaging is unsatisfactory because of the insensitivity or nonspecific findings of these imaging modalities. The purpose of this study was to investigate signal intensity changes of bone marrow after therapy by using diffusion-weighted MR imaging to monitor the response**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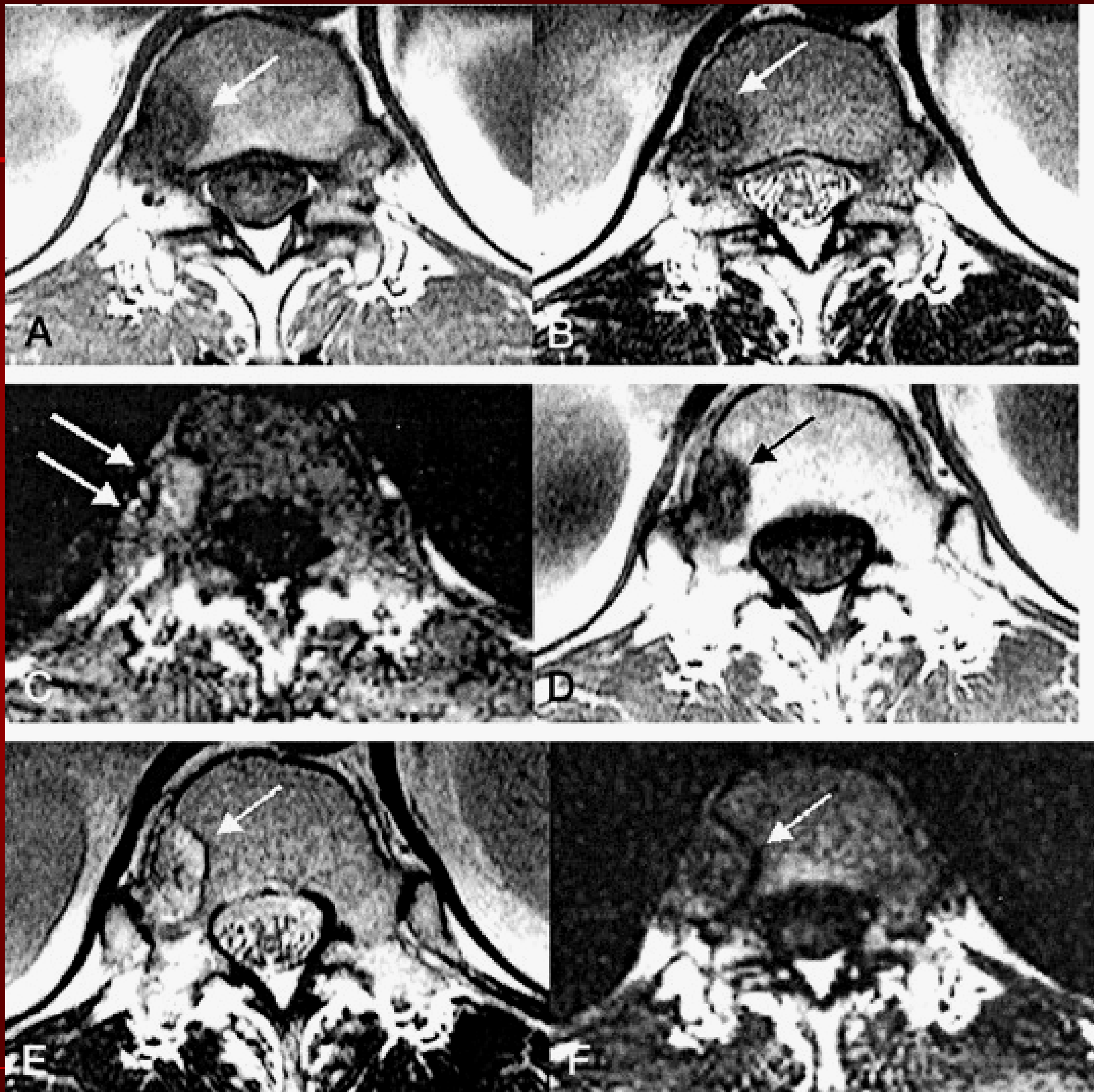
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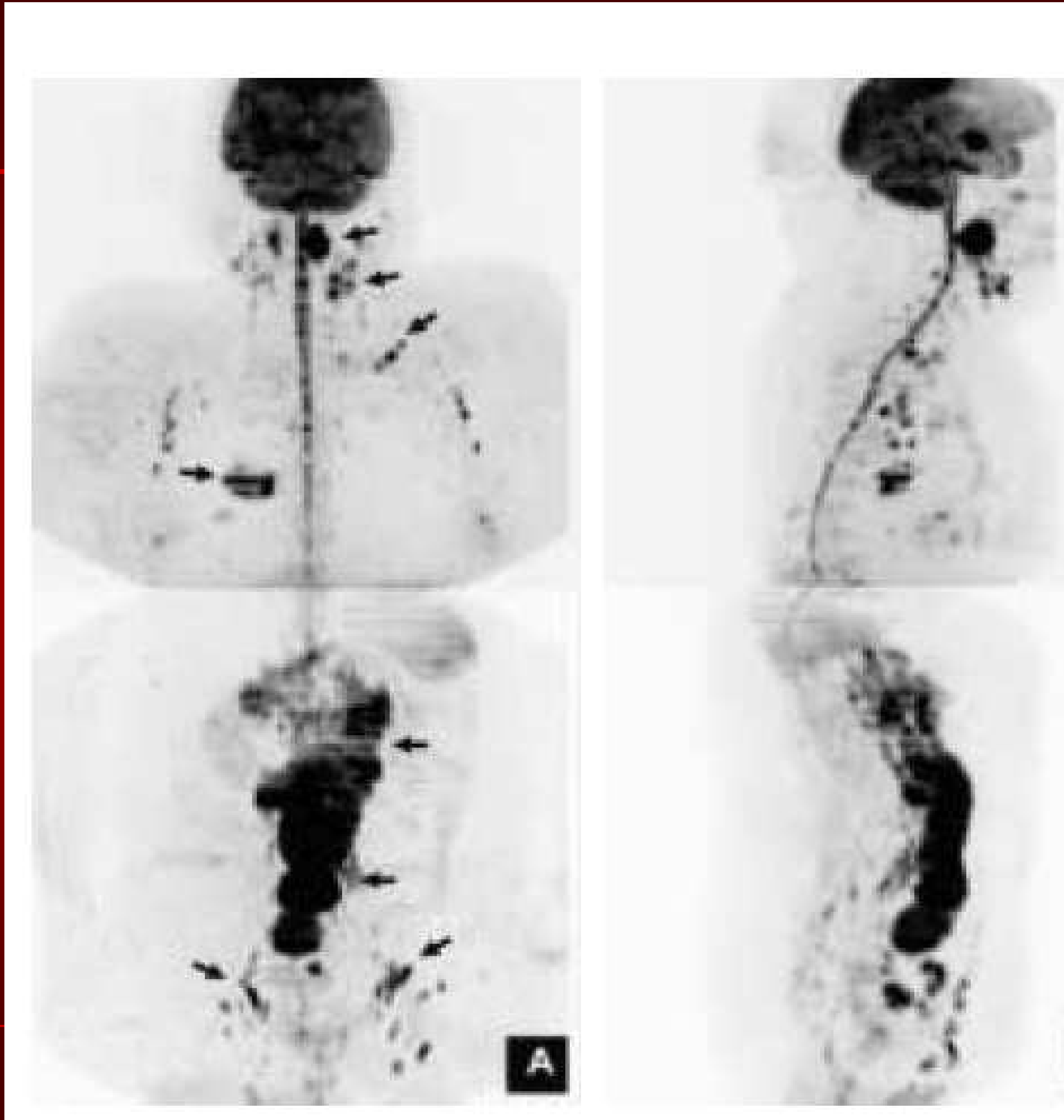
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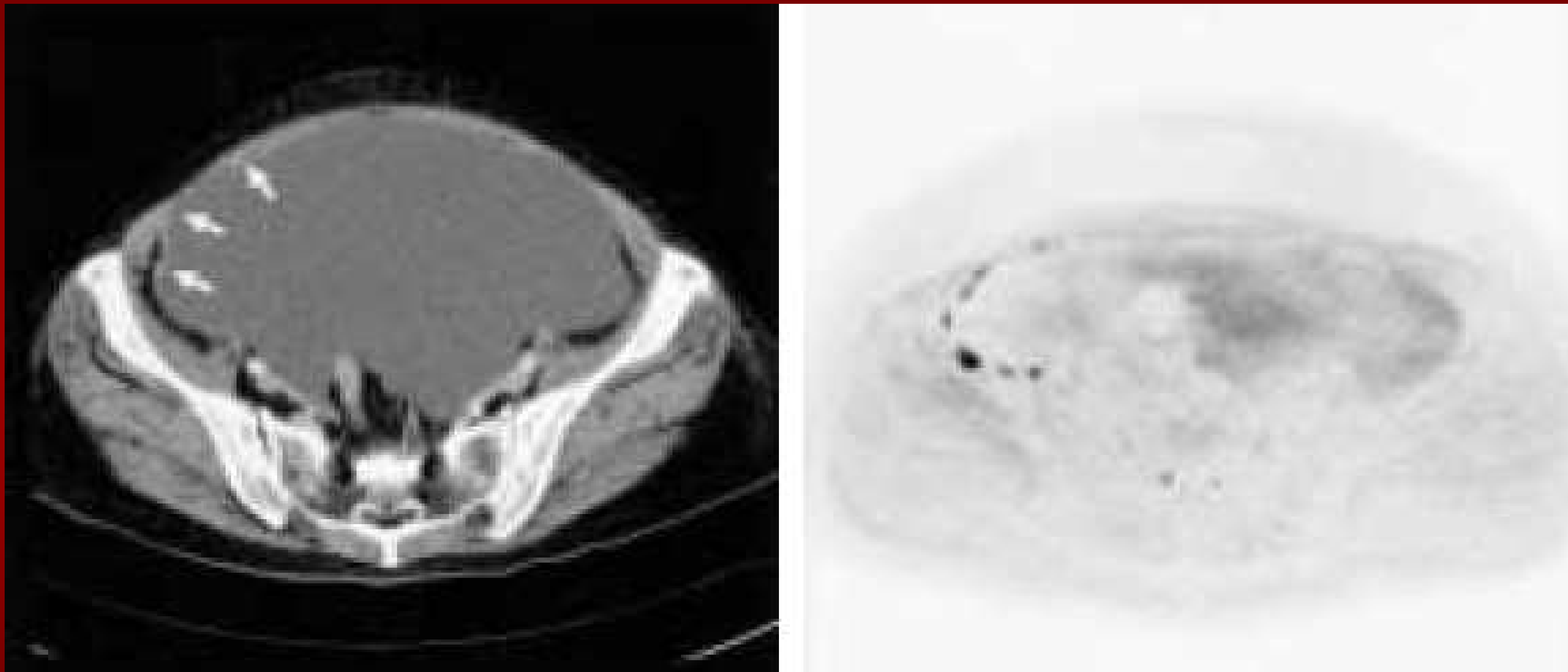

GRAZIE PER.... L'ATTENZIONE!