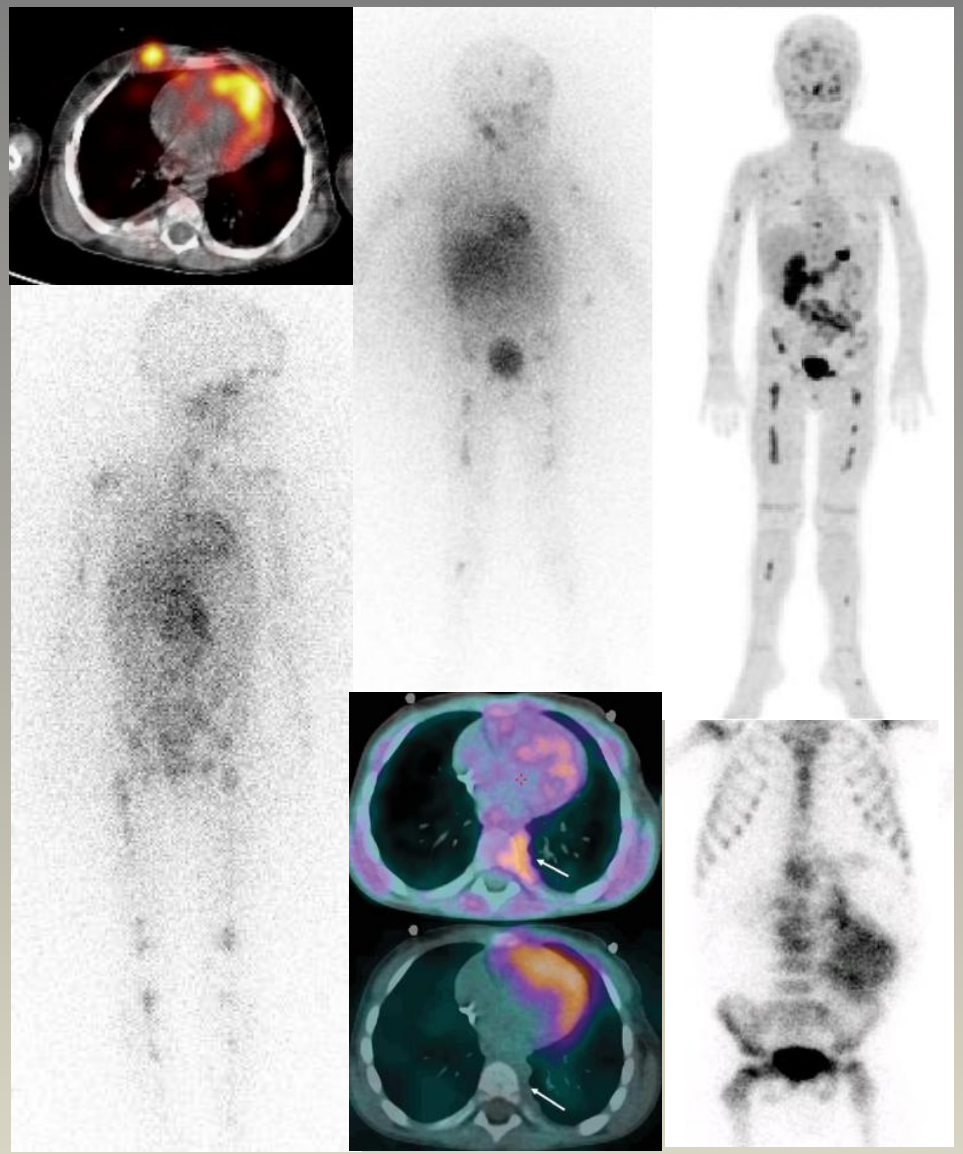
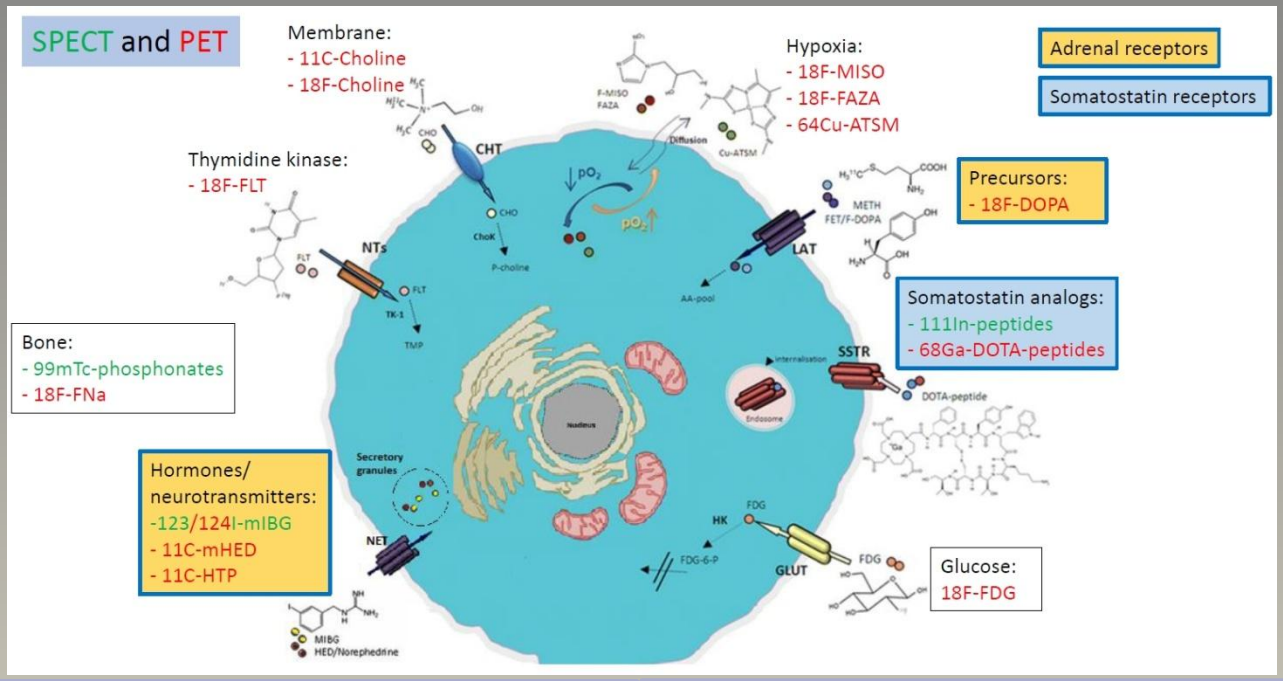
IMAGEN MOLECULAR EN EL NEUROBLASTOMA



Isabel Roca

Medicina Nuclear

IMAGEN MOLECULAR en el NEUROBLASTOMA



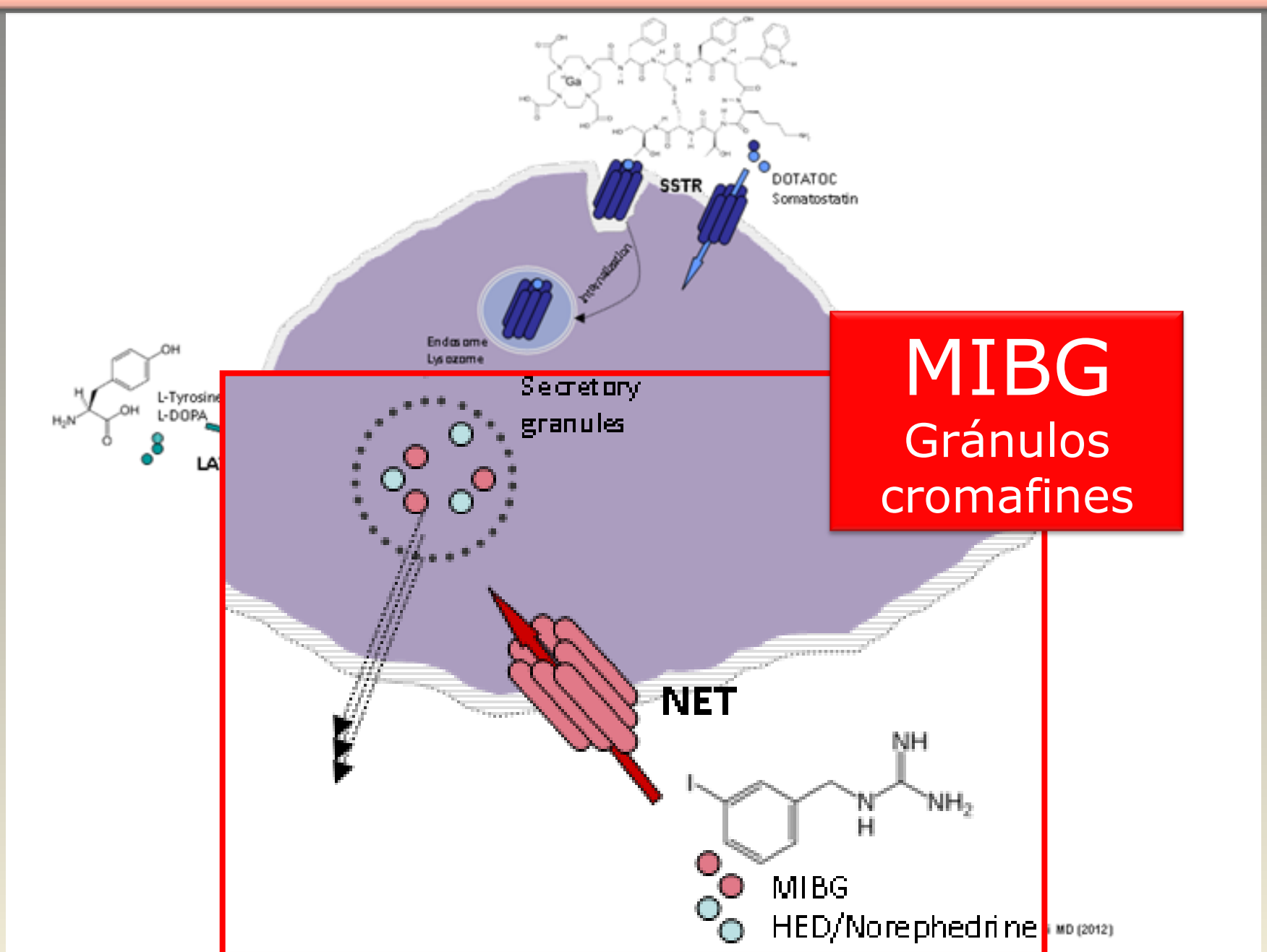
RADIOFÁRMACOS APROBADOS EN LAS GUIAS:

- **SPECT**
  - ^{123}I-MIBG
  - ^{131}I-MIBG
  - ^{99m}Tc-difosfonatos
- **PET**
  - ^{18}F-FDG
  - ^{18}F-DOPA
  - ^{68}Ga-DOTA
  - ^{18}F-Fluoruro

RADIOFÁRMACOS EN INVESTIGACIÓN:

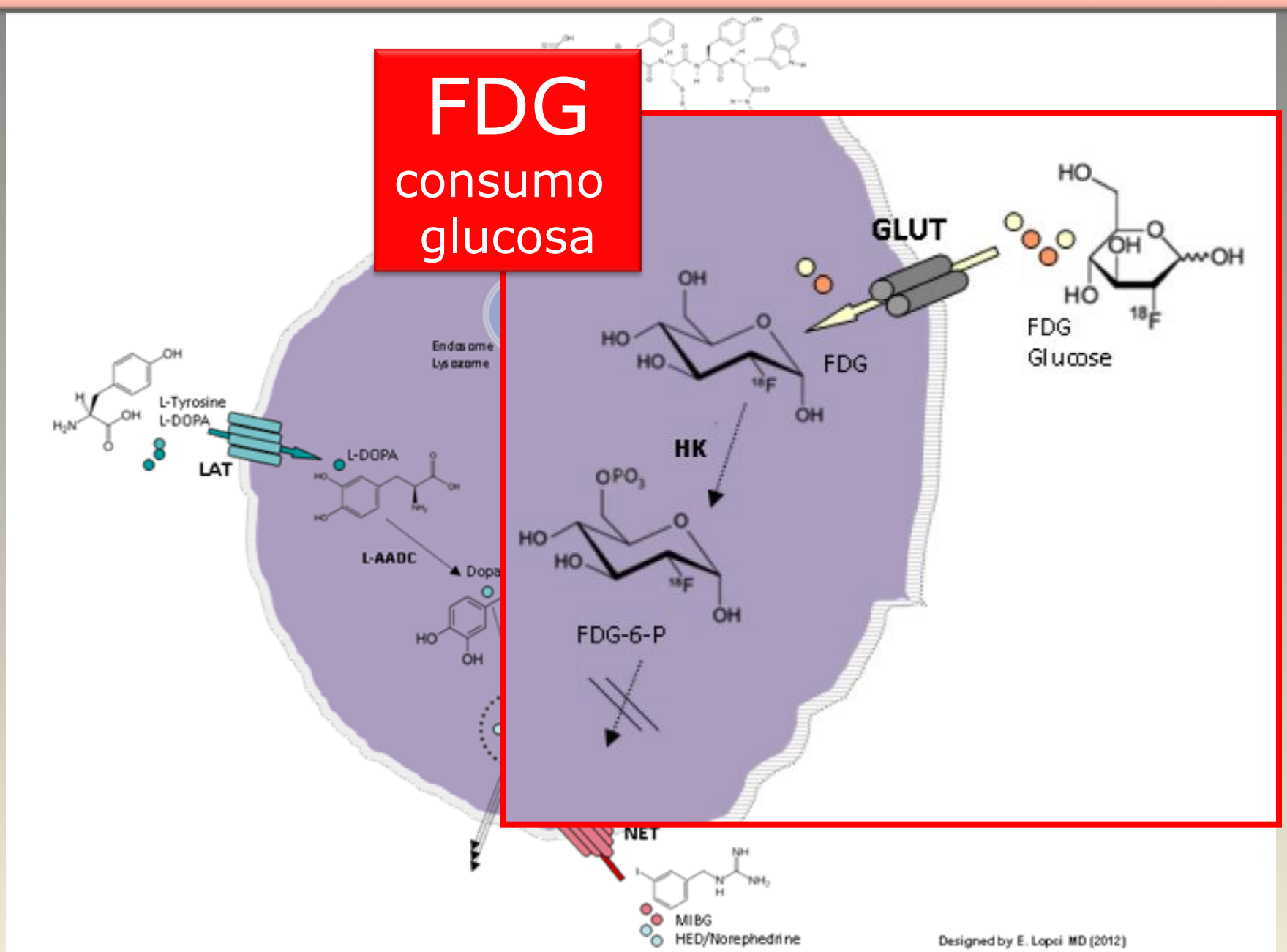
- **PET**
  - ^{124}I-MIBG
  - ^{18}F-FMBG
  - ^{18}F-FPBG

IMAGEN MOLECULAR en el NEUROBLASTOMA



MIBG
Gránulos cromafines

IMAGEN MOLECULAR en el NEUROBLASTOMA



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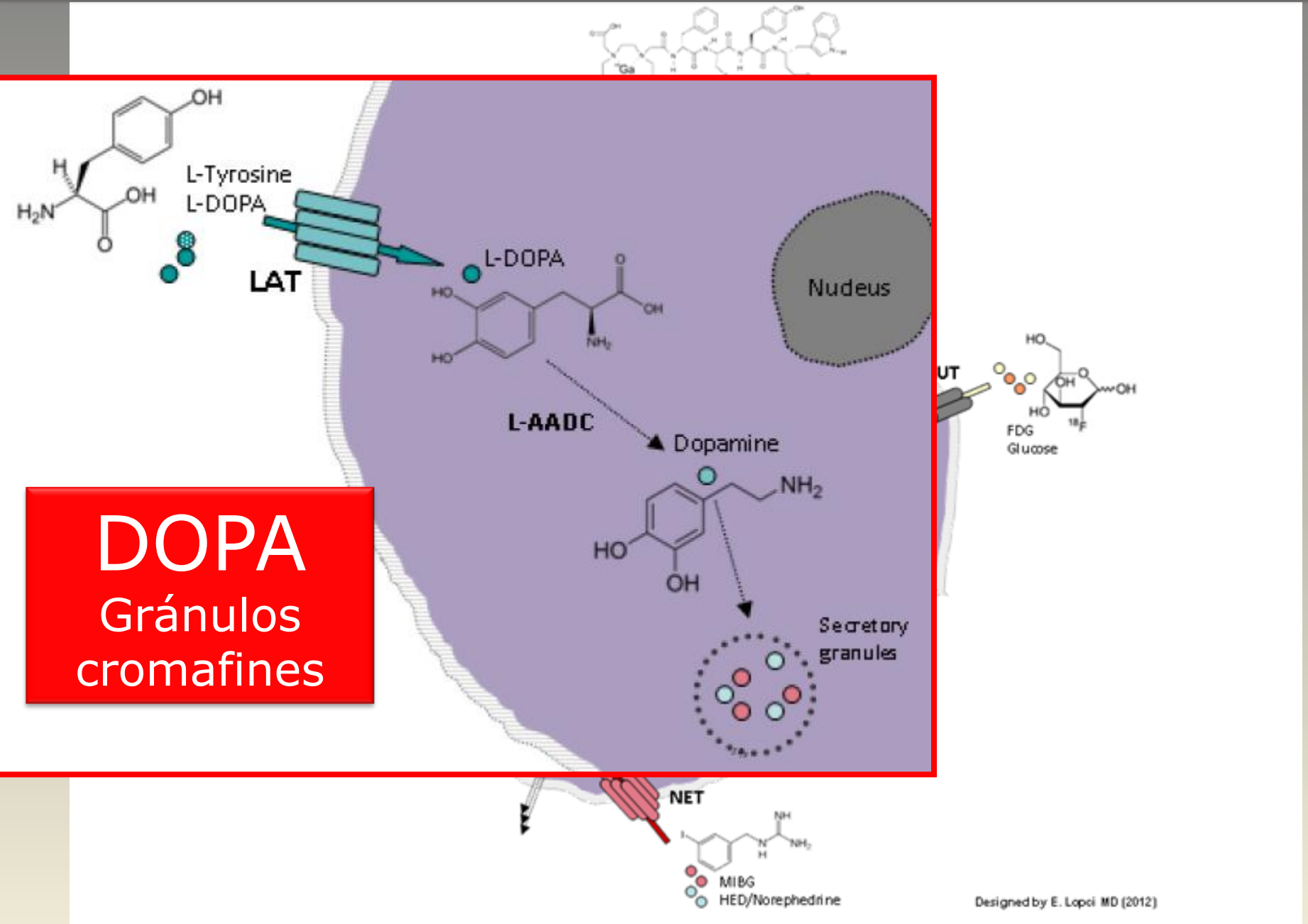
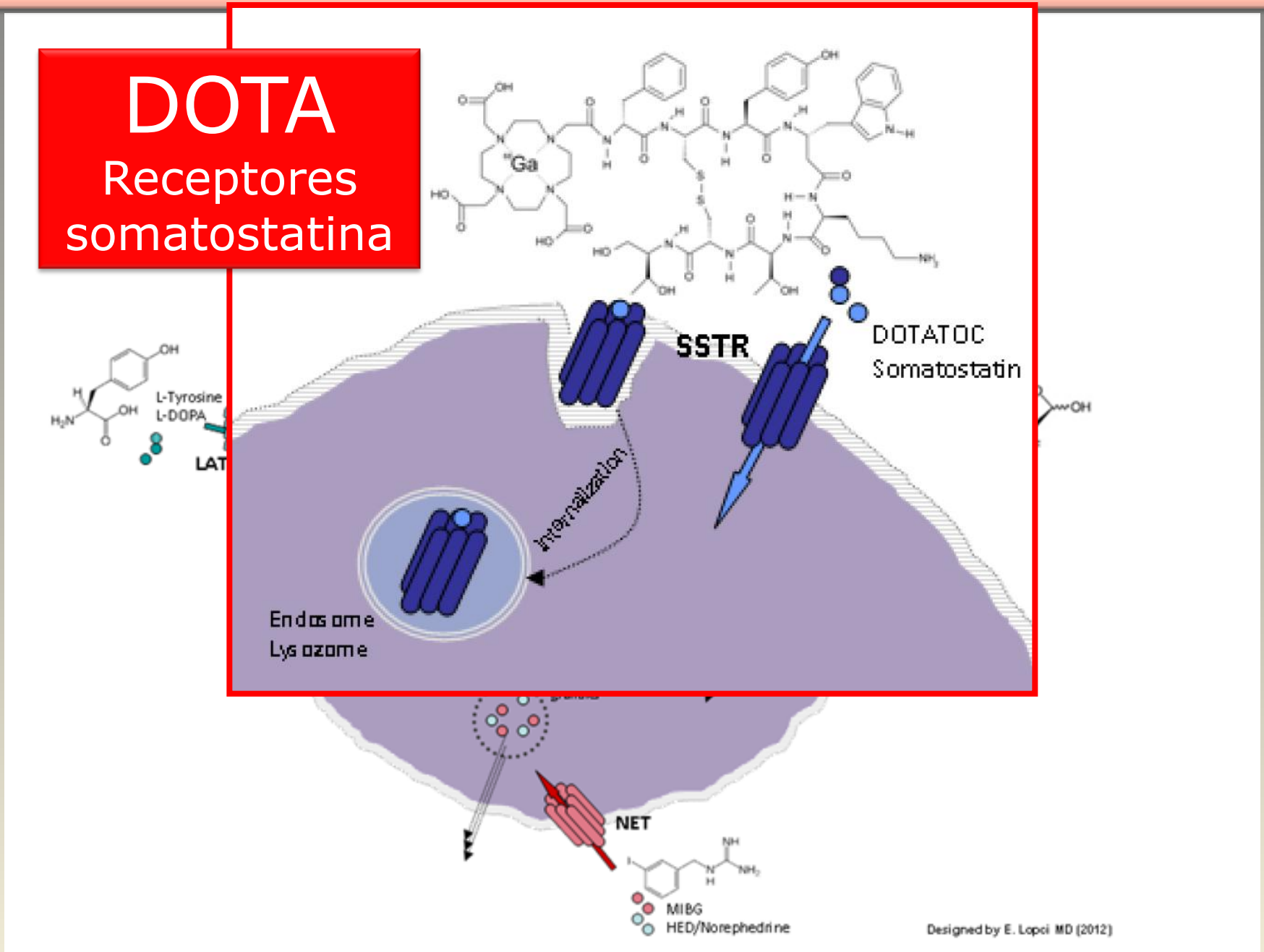


DOPA
Gránulos cromafines

IMAGEN MOLECULAR en el NEUROBLASTOMA



European Journal of Nuclear Medicine and Molecular Imaging (2018) 45:2009–2024
https://doi.org/10.1007/s00259-018-4070-8

GUIDELINES

Guidelines on nuclear medicine imaging in neuroblastoma

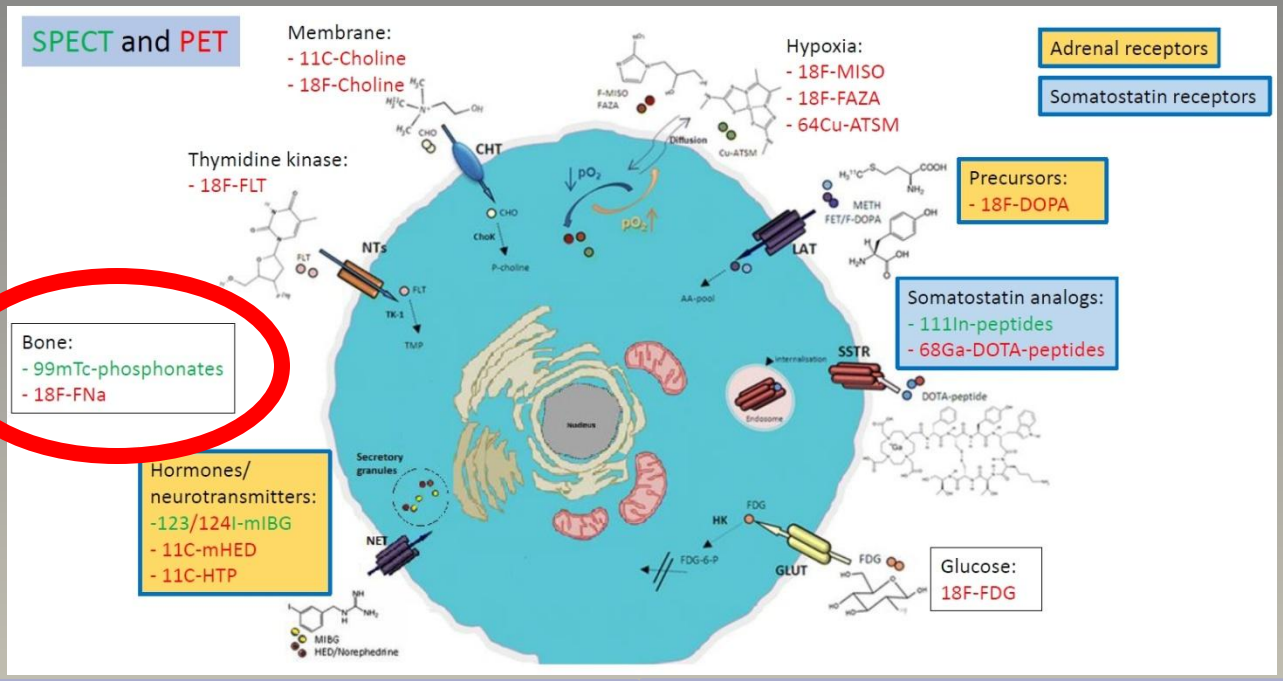
Zvi Bar-Sever[1] · Lorenzo Biassoni[2] · Barry Shulkin[3] · Grace Kong[4] · Michael S. Hofman[4] · Egesta Lopci[5] · Irina Manea[6] · Jacek Koziorowski[6] · Rita Castellani[7] · Ariane Boubaker[8] · Bieke Lambert[9] · Thomas Pfluger[10] · Helen Nadel[11] · Susan Sharp[12] · Francesco Giammarile[13]

Published online: 25 June 2018

Abstract

Nuclear medicine has a central role in the diagnosis, staging, response assessment and long-term follow-up of neuroblastoma, the most common solid extracranial tumour in children. These EANM guidelines include updated information on ^{123}I-mIBG, the most common study in nuclear medicine for the evaluation of neuroblastoma, and on PET/CT imaging with ^{18}F-FDG, ^{18}F-DOPA and ^{68}Ga-DOTA peptides. These PET/CT studies are increasingly employed in clinical practice. Indications, advantages and limitations are presented along with recommendations on study protocols, interpretation of findings and reporting results.

GAMMAGRAFÍA o PET ÓSEO



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  - ^{68}Ga-DOTA
  - ^{18}F-Fluoruro

RADIOFÁRMACOS EN INVESTIGACIÓN:

- **PET**
  - ^{124}I-MIBG
  - ^{18}F-FMBG
  - ^{18}F-FPBG

GAMMAGRAFÍA o PET ÓSEO

- Detección mets óseas
- Lesiones corticales óseas

- 50% captación primario

- captación submetafisaria difusa = mets medulares

- menor sensibilidad que
  - MIBG FP y FN
  - FDG

Park JR, Bagatell R, Cohn SL, Pearson AD, Villablanca JG, Berthold F, Burchill S, Boubaker A, McHugh K, Nuchtern JG, London WB, Seibel NL, Lindwasser OW, Maris JM, Brock P, Schleiermacher G, Ladenstein R, Matthay KK, Valteau-Couanet D. Revisions to the International Neuroblastoma Response Criteria: A Consensus Statement From the National Cancer Institute Clinical Trials Planning Meeting. J Clin Oncol. 2017 Aug 1;35(22):2580-2587.

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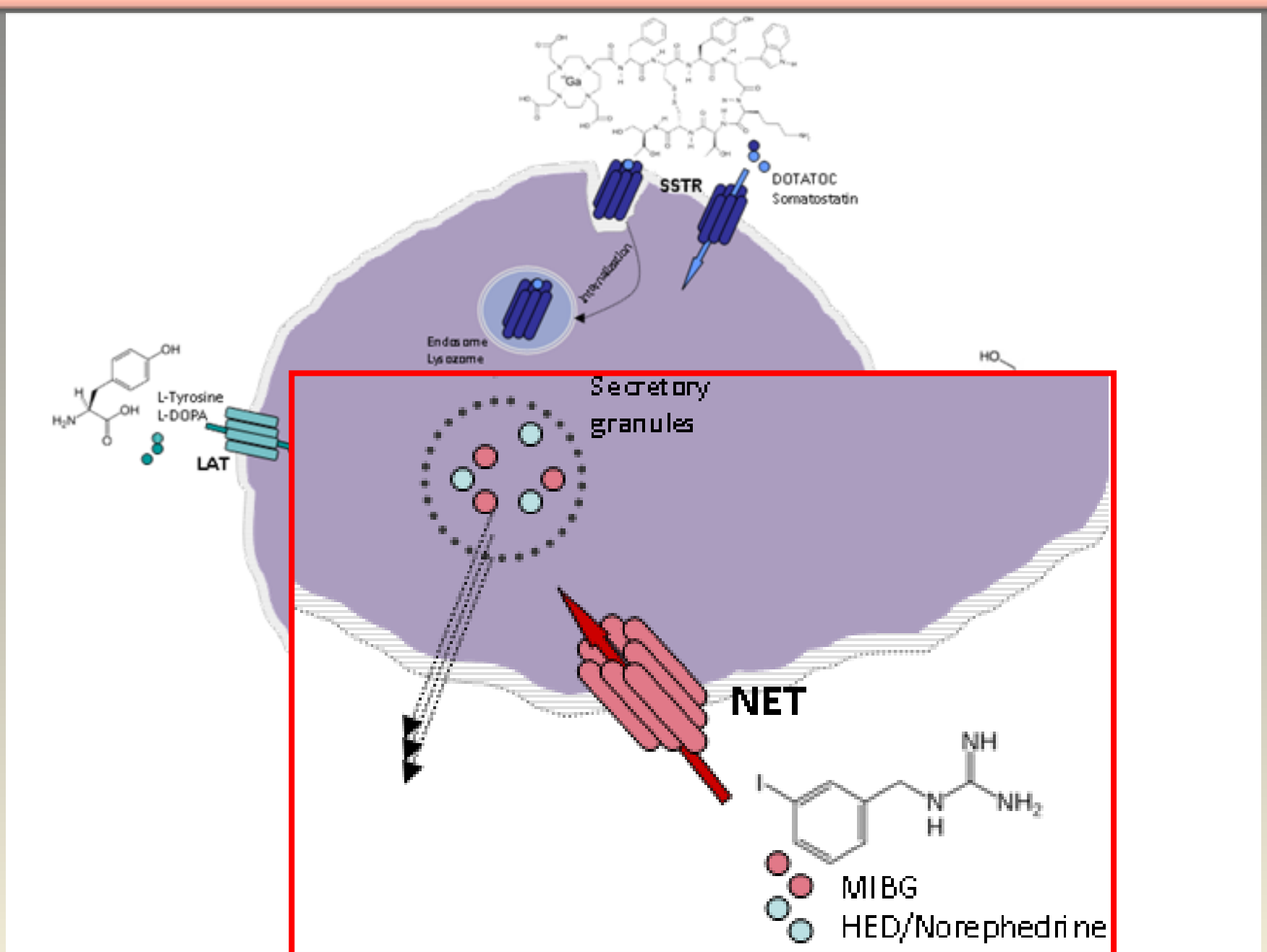
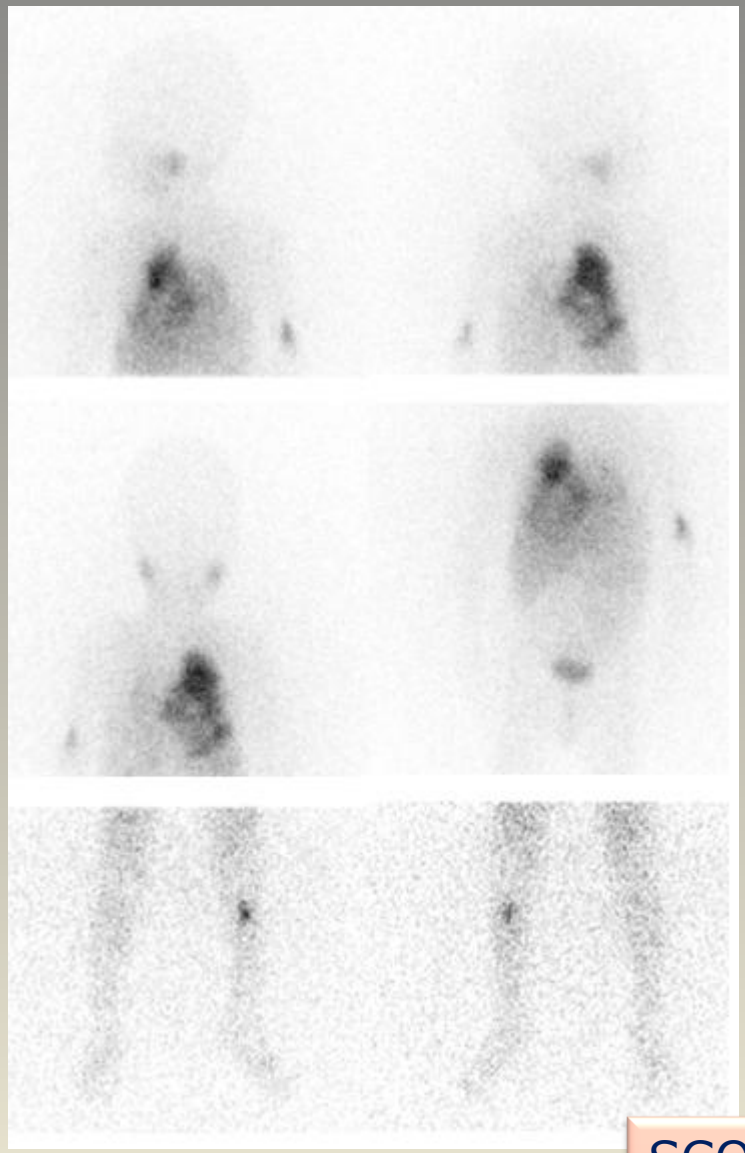
MIBG

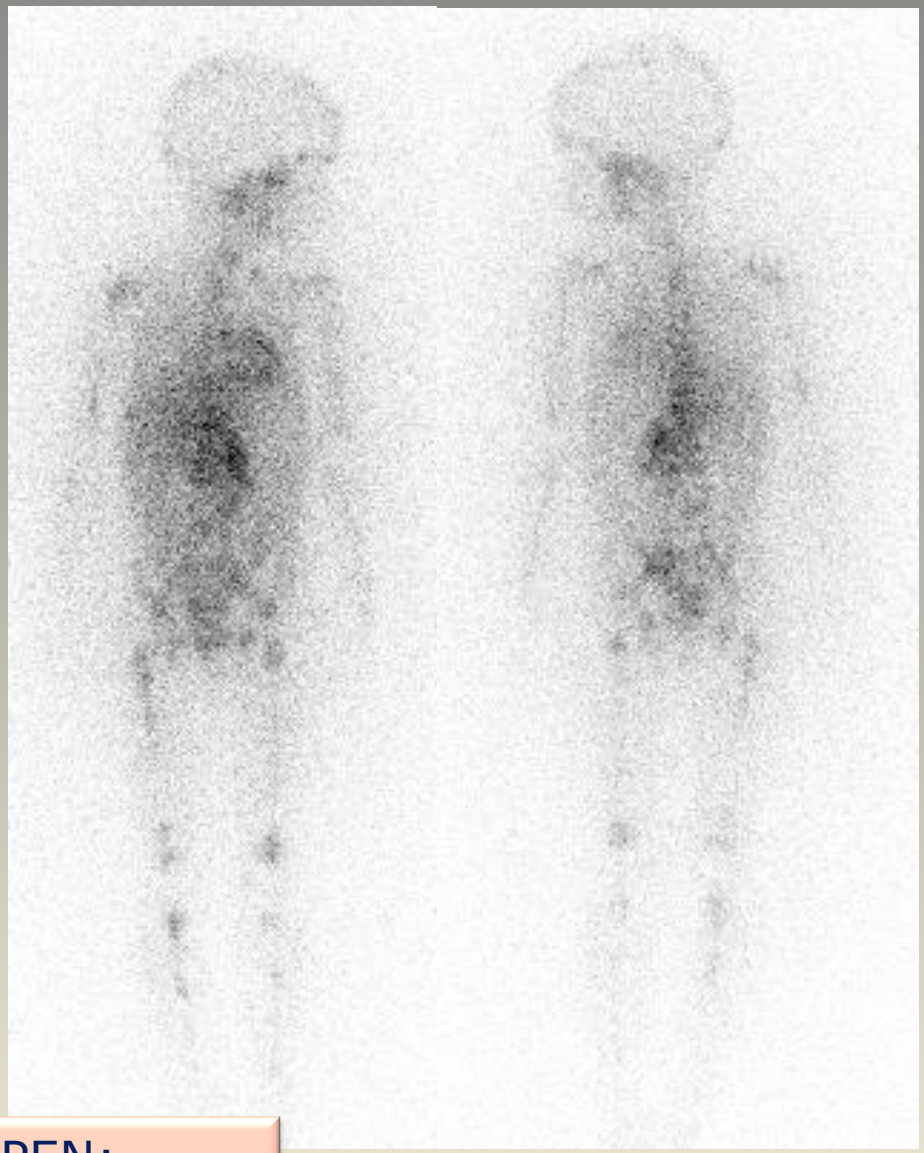

SSTR
DOTATOC
Somatostatin
Internalization
Endosome
Lysozome
L-Tyrosine
L-DOPA
LAT
Secretory
granules
NET
MIBG
HED/Norephedrine

GAMMAGRAFÍA ^{123}I-MIBG



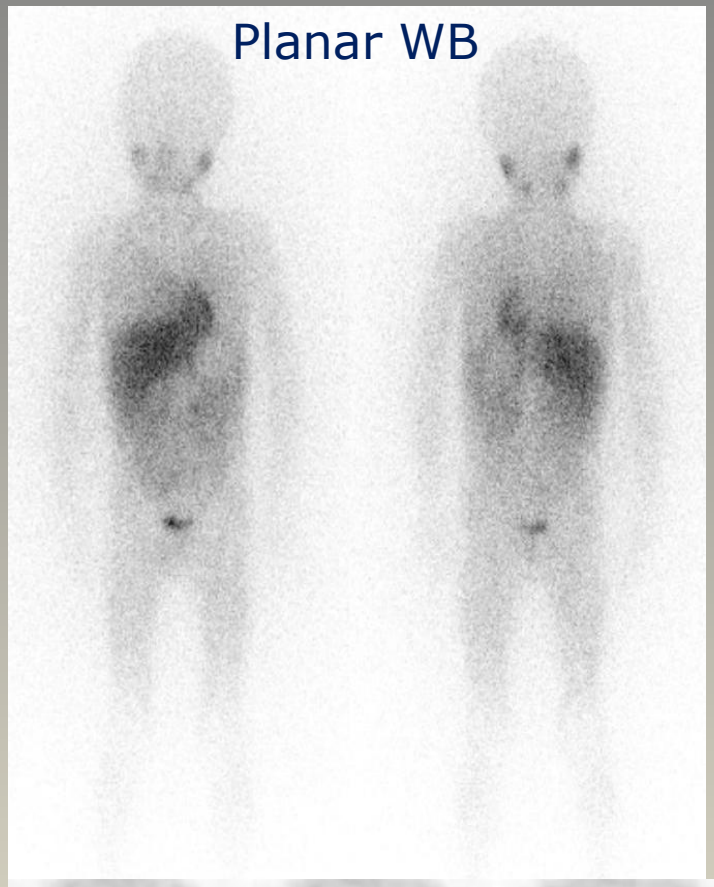
Planar spots

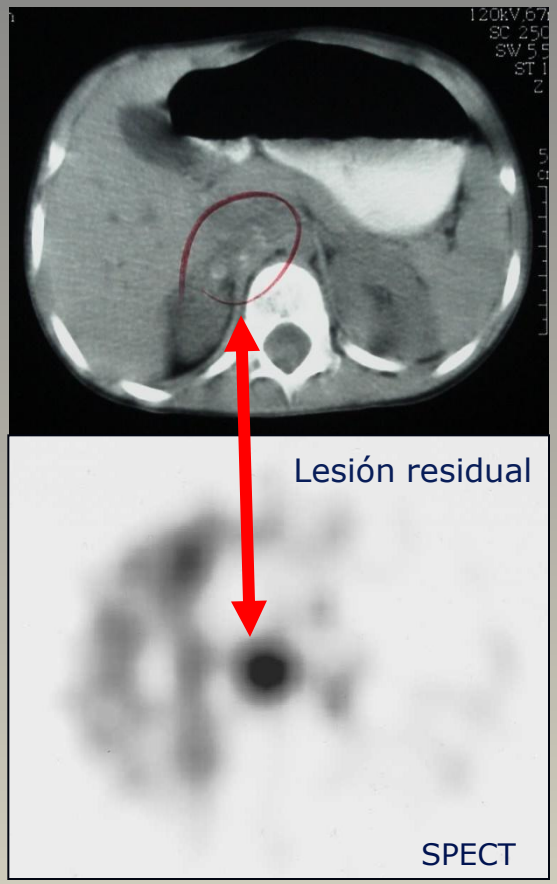
SCORE SIOPEN:
IMÁGENES PLANARES

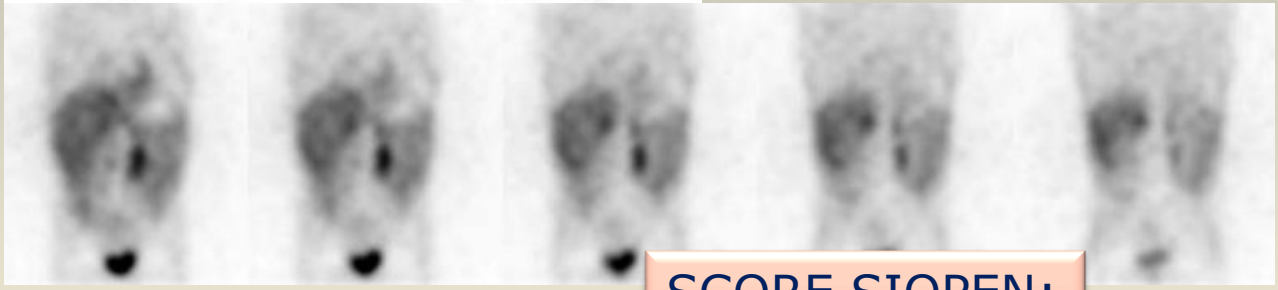


Planar WB

GAMMAGRAFÍA ^{123}I-MIBG con SPECT o SPECT-CT





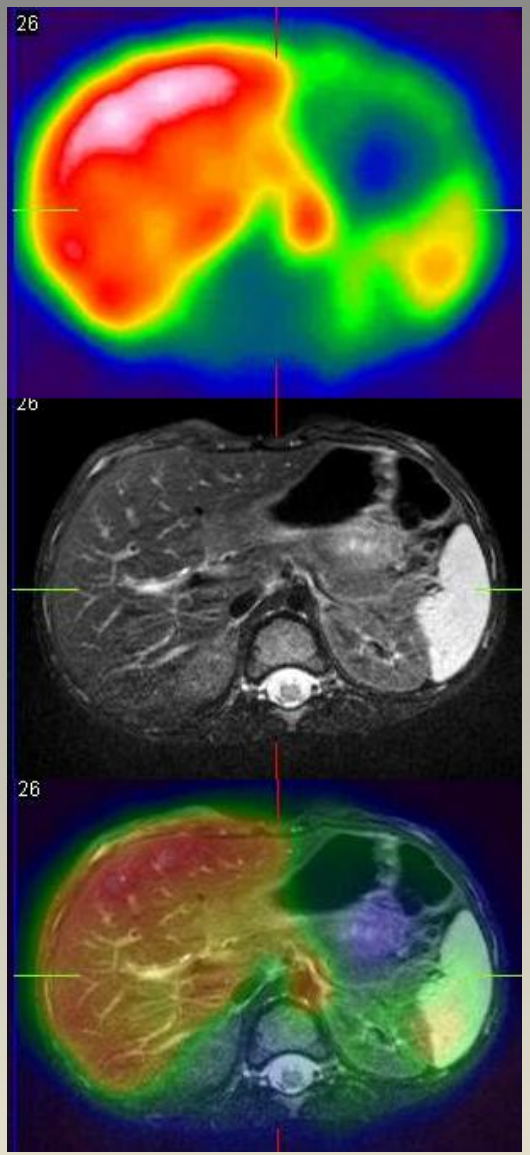


SPECT
coronal

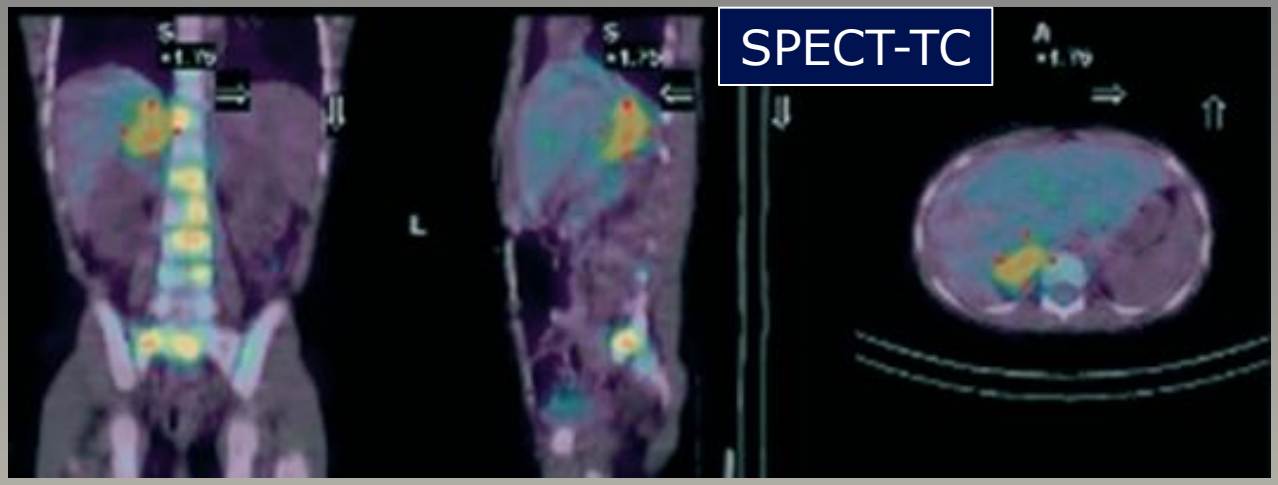
SCORE SIOPEN:
no valora SPECT

Las imágenes tomográficas **SPECT** y **SPECT-TC** son más **sensibles** que las imágenes planares para detectar lesiones

GAMMAGRAFÍA ^{123}I-MIBG con SPECT o SPECT-CT



Fusión softw
SPECT-RM



Las imágenes tomográficas **SPECT** se pueden adquirir directamente como **SPECT-TC en una gammacámara híbrida SPECT-TC** o bien adquirir solo **SPECT** (mucha menor dosimetría) y fusionar por software con RM

35 NBL patients
Estadíos 3 y 4

54% pacientes lesiones:
- SPECT + Planares –

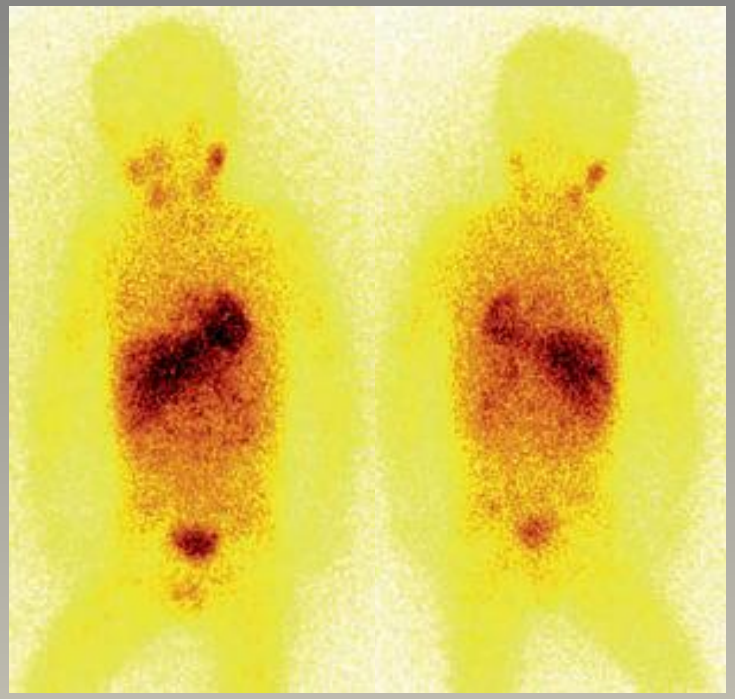
89% confirmadas por TC o RM

10 NBL patients
Estadío 1

10% pacientes lesiones:
- SPECT + Planares –

45 NBL patients, 213 MIBG
Todos los estadíos

25% pacientes lesiones de partes blandas



Superiority of SPECT/CT over planar ^{123}I-mIBG images in neuroblastoma patients with impact on Curie and SIOPEN score values

Igor Černý; Jiri Prášek; Helena Kašpárková
Clinic of Nuclear medicine, University Hospital Brno and Masaryk University – Faculty of Medicine, Brno, Czech Republic

Černý I, Prášek J, Kašpárková H. Superiority of SPECT/CT over planar 123I-mIBG images in neuroblastoma patients with impact on Curie and SIOPEN score values. Nuklearmedizin. 2016 Aug 5;55(4):151-7.

SENSIBILIDAD MIBG AL DIAGNÓSTICO

Tumor	Ref.	Average age	% Males	No. of subjects with confirmed disease	Sensitivity (exact 95% CI), %	No. of disease-free subjects	Specificity (exact 95% CI), %
Neuroblastoma	36	6.9 months	61	33	100 (89, 100)		
	37	43.9 months	45	17	76 (50, 93)		
	38	3.5 yr	70	19	89 (67, 99)		
	39	8 months	53	19	100 (82, 100)		
	40	14 months	55	88	94 (87, 98)		
	41	2.64 yr	60	20	100 (83, 100)		
	42	10 months	37	27	100 (87, 100)		

Jacobson AF, Deng H, Lombard J, Lessig HJ, Black RR. 123I-meta-iodobenzylguanidine scintigraphy for the detection of neuroblastoma and pheochromocytoma: results of a meta-analysis. J Clin Endocrinol Metab. 2010 Jun;95(6):2596-606.

SENSIBILIDAD MIBG AL DIAGNÓSTICO O EN RECURRENCIA

Objective 1.1 ^{123}I-MIBG scintigraphy for diagnosing a neuroblastoma and its metastases at first diagnosis or at recurrence

Patients/population: children from 0 to 18 years old with a suspected neuroblastoma of any stage at first diagnosis or at recurrence.

Setting: tertiary care centres of paediatric oncology.

Index test: ^{123}I-MIBG scintigraphy (whole-body(WB), SPECT or SPECT-CT).

Reference test: gold standard is histopathology and or bone marrow biopsies/trephine biopsies, but that was not always performed; so also: histopathology during or after treatment (e.g. tissue obtained during surgery), if urinary metabolites were elevated at diagnosis and additional imaging modalities (e.g. ultrasound, CT scan, MRI scan) suggested a neuroblastoma at diagnosis.

Studies: primary diagnostic cohort studies (retrospective and prospective), cross-sectional study.

Subgroup	Second covariate	Sensitivity	Specificity	Number of participants (studies) unless otherwise stated
Neuroblastoma at first diagnosis or at recurrence (all stages)	-	Range: 0.67 to 1.00	0.68[a] (one study)	608 (11 studies)
Metastases (osteomedullary and soft tissue)	-	Range: 0.79 to 1.00	Range: 0.33 to 0.89 (two studies, 45 patients)	72 (3 studies)
Stage 1 and 2				
Stage 3				
Stage 4				
Stage 4				
Stage 4S				(1 study)

^{123}I-MIBG
- WB
- SPECT
  or
- SPECT-CT

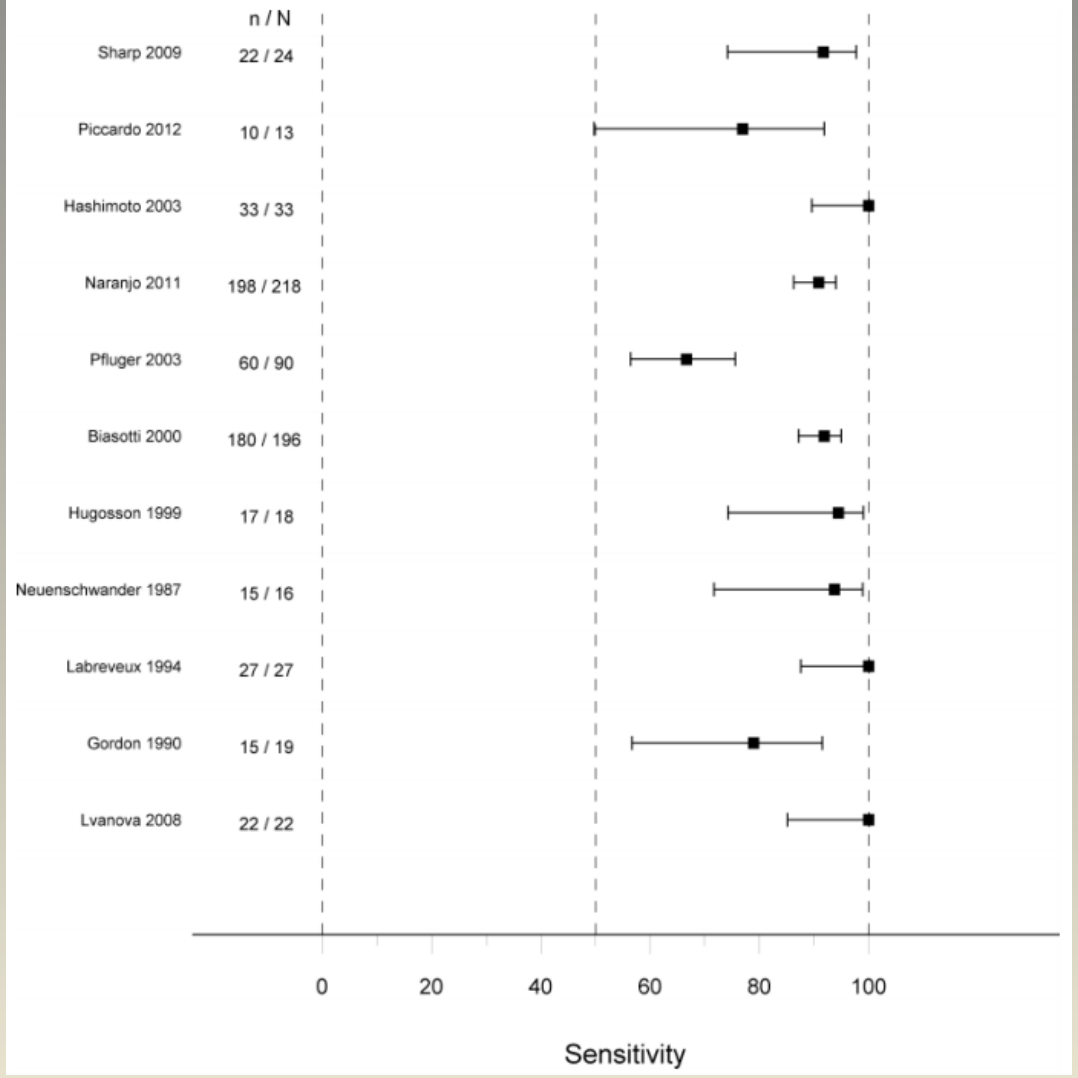
SENSIBILIDAD

- AL DIAGNÓSTICO 67-100%
- METS OSTEOMEDULARES Y PARTES BLANDAS 79-100%
- ESTADIOS 3-4-5 > 1-2

Bleeker G, Tytgat GA, Adam JA, Caron HN, Kremer LC, Hooft L, van Dalen EC. 123I-MIBG scintigraphy and 18F-FDG-PET imaging for diagnosing neuroblastoma. Cochrane Database Syst Rev. 2015 Sep 29;(9):CD009263.

SENSIBILIDAD MIBG AL DIAGNÓSTICO O EN RECURRENCIA

Figure 5. Sensitivity of 123I-MIBG (SPECT-CT) scintigraphy for detecting a neuroblastoma tumour and its metastases at first diagnosis or at recurrence in children from 0 to 18 years old (with 95% confidence interval). Abbreviations: n: number of patients with true positive results of ^{123}I-MIBG scintigraphy, for Pfluger 2003: number of lesions. N: total number of patients with ^{123}I-MIBG scintigraphy, for Pfluger 2003: total number of lesions.



^{123}I-MIBG

- SPECT-CT

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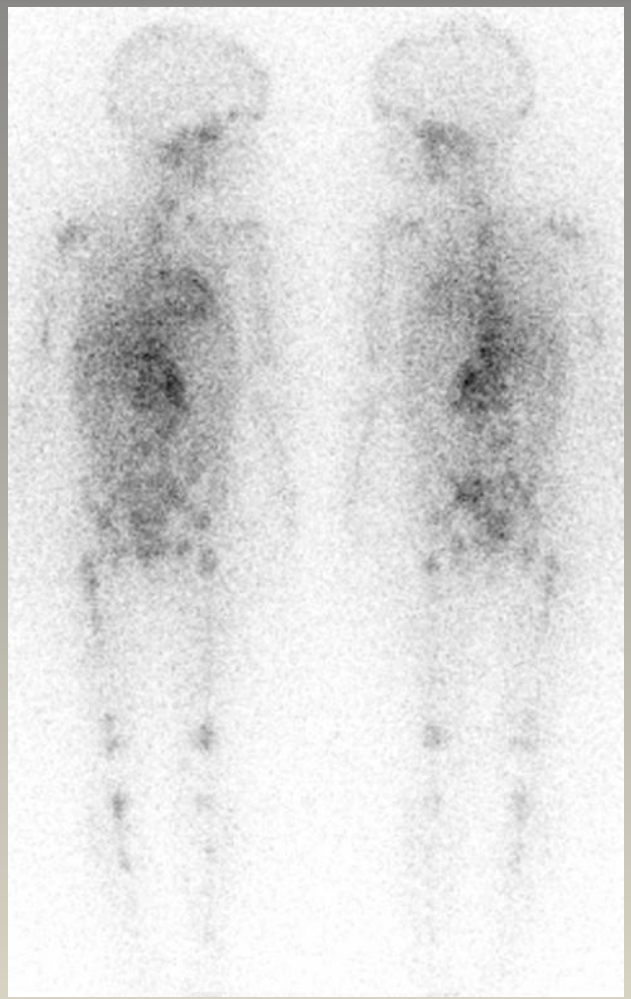
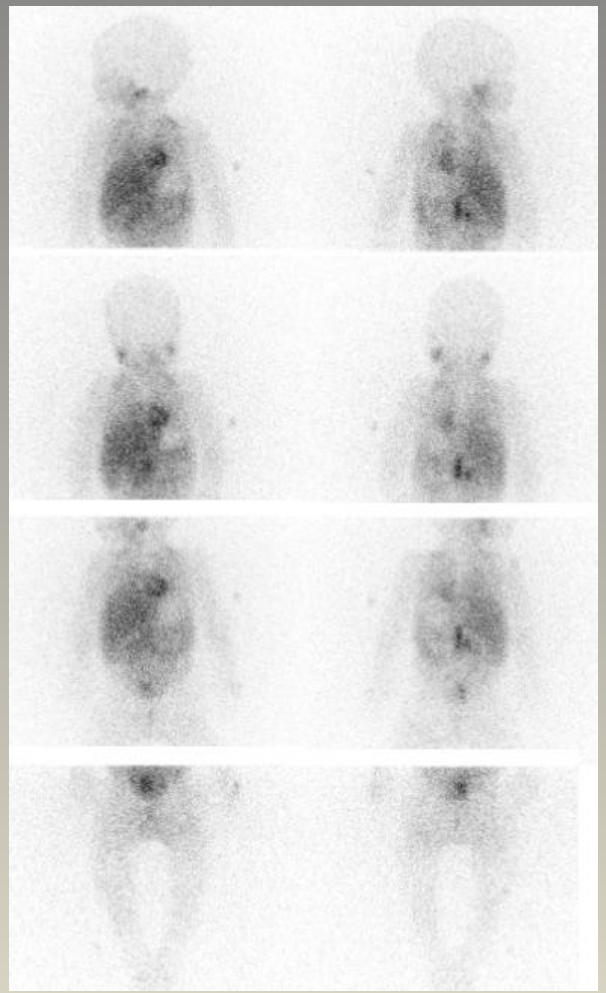
MIBG AL DIAGNÓSTICO





Patrón distribución gammagráfico

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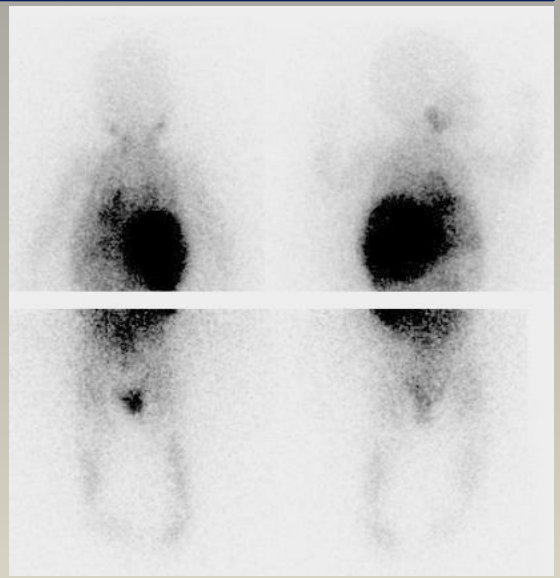
Estadío clínico



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Bleeker G, van Eck-Smit BL, Zwinderman KH, Versteeg R, van Noesel MM, Kam BL, Kaspers GJ, van Schie A, Kreissman SG, Yanik G, Hero B, Schmidt M, Laureys G, Lambert B, Øra I, Schulte JH, Caron HN, Tytgat GA. MIBG scans in patients with stage 4 neuroblastoma reveal two metastatic patterns, one is associated with MYCN amplification and in MYCN-amplified tumours correlates with a better prognosis. Eur J Nucl Med Mol Imaging. 2015 Feb;42(2):222-30.

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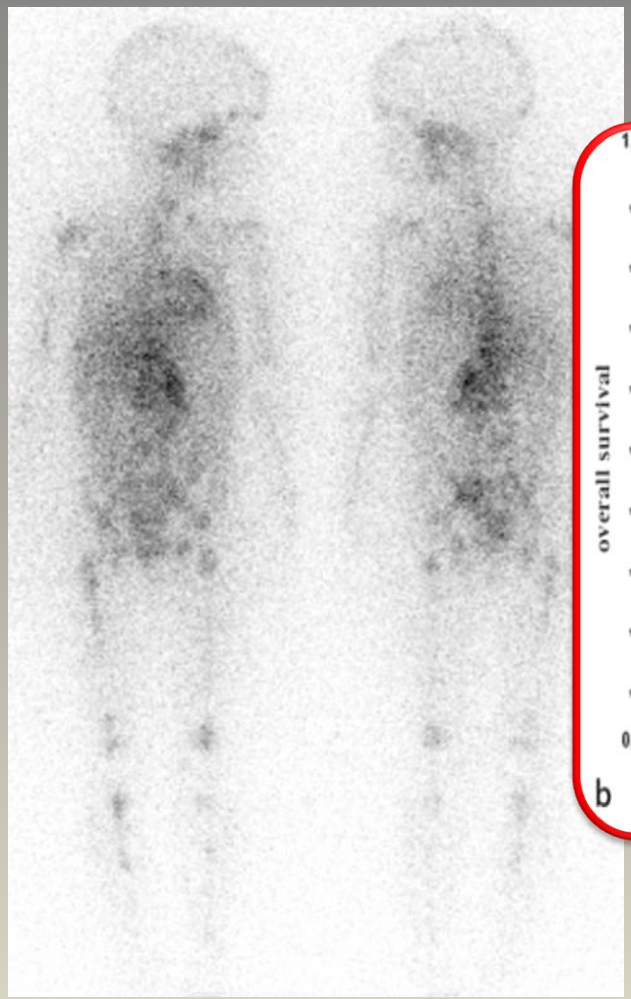
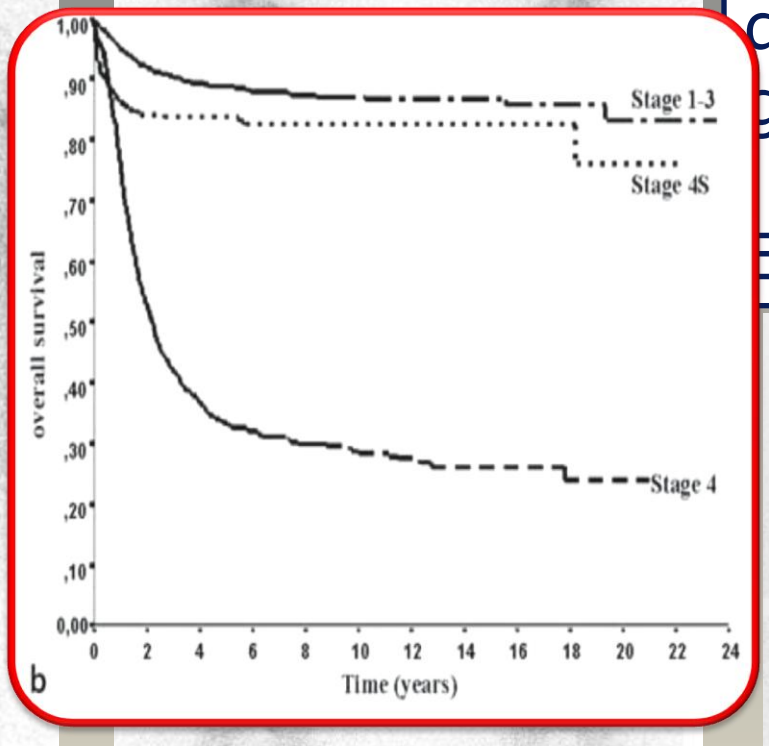
Sharp SE, Shulkin BL, Gelfand MJ, Salisbury S, Furman WL. 123I-MIBG scintigraphy and 18F-FDG PET in neuroblastoma. J Nucl Med. 2009 Aug;50(8):1237-43.

Vik TA, Pfluger T, Kadota R, Castel V, Tulchinsky M, Farto JC, Heiba S, Serafini A, Tumeh S, Khutoryansky N, Jacobson AF. (123)I mIBG scintigraphy in patients with known or suspected neuroblastoma: Results from a prospective multicenter trial. Pediatr Blood Cancer. 2009 Jul;52(7):784-90.

Yanik GA, Parisi MT, Shulkin BL, Naranjo A, Kreissman SG, London WB, Villablanca JG, Maris JM, Park JR, Cohn SL, McGrady P, Matthay KK. Semiquantitative mIBG scoring as a prognostic indicator in patients with stage 4 neuroblastoma: a report from the Children's oncology group. J Nucl Med. 2013 Apr;54(4):541-8.

MIBG AL DIAGNÓSTICO





Patrón distribución gammagráfico

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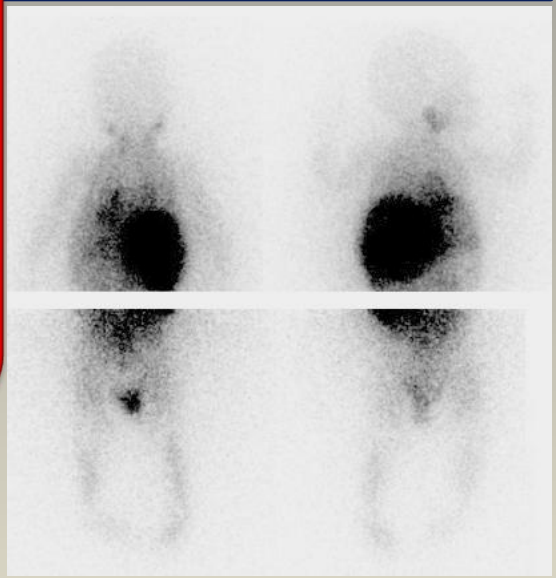
Estadío clínico



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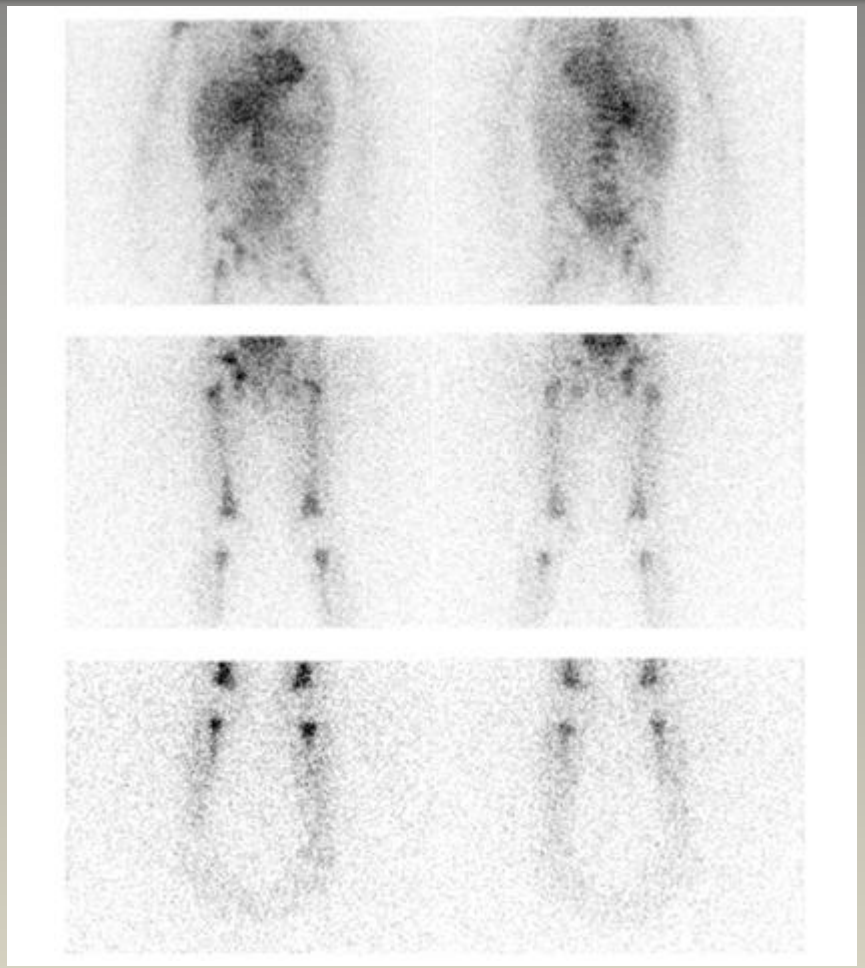
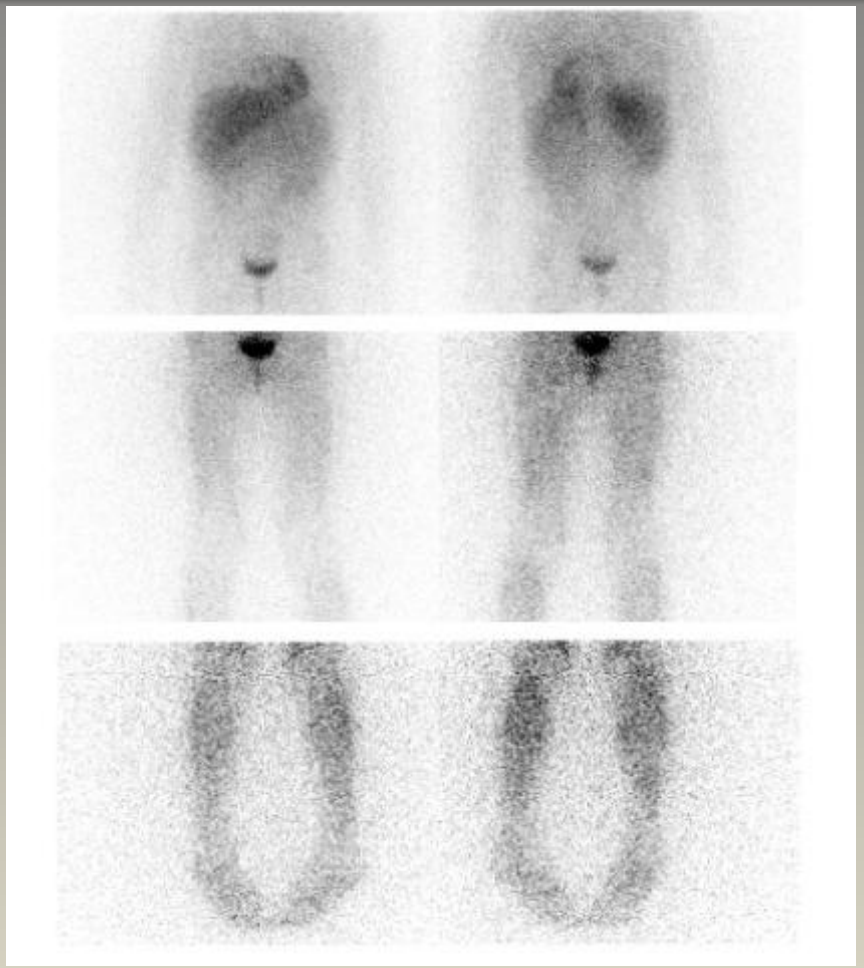
MIBG – valoración respuesta terapia



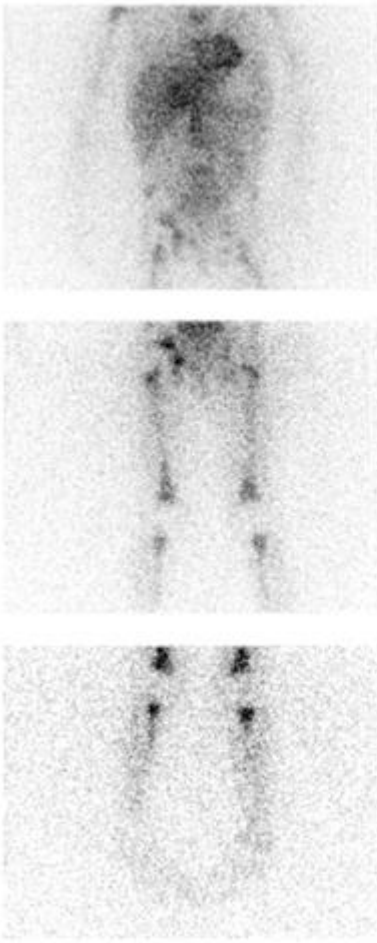
Estadío 4



RC

Park JR, Bagatell R, Cohn SL, Pearson AD, Villablanca JG, Berthold F, Burchill S, Boubaker A, McHugh K, Nuchtern JG, London WB, Seibel NL, Lindwasser OW, Maris JM, Brock P, Schleiermacher G, Ladenstein R, Matthay KK, Valteau-Couanet D. Revisions to the International Neuroblastoma Response Criteria: A Consensus Statement From the National Cancer Institute Clinical Trials Planning Meeting. J Clin Oncol. 2017 Aug 1;35(22):2580-2587.

MIBG – valoración respuesta terapia



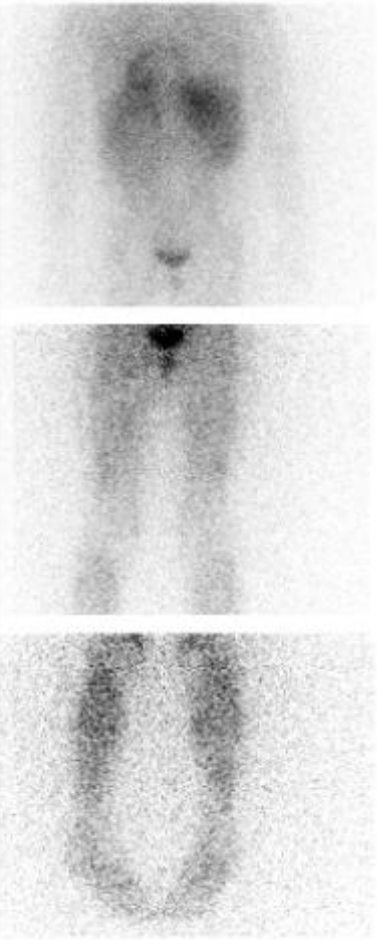


Table 2. Primary (soft tissue) Tumor Response*

Response	Anatomic + MIBG (FDG-PET†) Imaging
CR	< 10 mm residual soft tissue at primary site AND Complete resolution of MIBG or FDG-PET uptake (for MIBG-nonavid tumors) at primary site
PR	≥ 30% decrease in longest diameter of primary site AND MIBG or FDG-PET uptake at primary site stable, improved, or resolved
PD	> 20% increase in longest diameter taking as reference the smallest sum on study (this includes the baseline sum if that is the smallest on study) AND Minimum absolute increase of 5 mm in longest dimension‡
SD	Neither sufficient shrinkage for PR nor sufficient increase for PD at the primary site

Abbreviations: CR, complete response; FDG, [^{18}F]fluorodeoxyglucose; MIBG, metaiodobenzylguanidine; PD, progressive disease; PET, positron emission tomography; PR, partial response; SD, stable disease.

*Not for use in assessment of metastatic sites.

†Used for MIBG-nonavid tumors.

‡Mass that does not meet PD measurement criteria but has fluctuating MIBG avidity will not be considered PD.

Park JR, Bagatell R, Cohn SL, Pearson AD, Villablanca JG, Berthold F, Burchill S, Boubaker A, McHugh K, Nuchtern JG, London WB, Seibel NL, Lindwasser OW, Maris JM, Brock P, Schleiermacher G, Ladenstein R, Matthay KK, Valteau-Couanet D. Revisions to the International Neuroblastoma Response Criteria: A Consensus Statement From the National Cancer Institute Clinical Trials Planning Meeting. J Clin Oncol. 2017 Aug 1;35(22):2580-2587.

EVALUACIÓN CUANTITATIVA

SIOP-EN: hoja de recogida de datos

International Society of Paediatric Oncology – European Neuroblastoma

Cuantificación

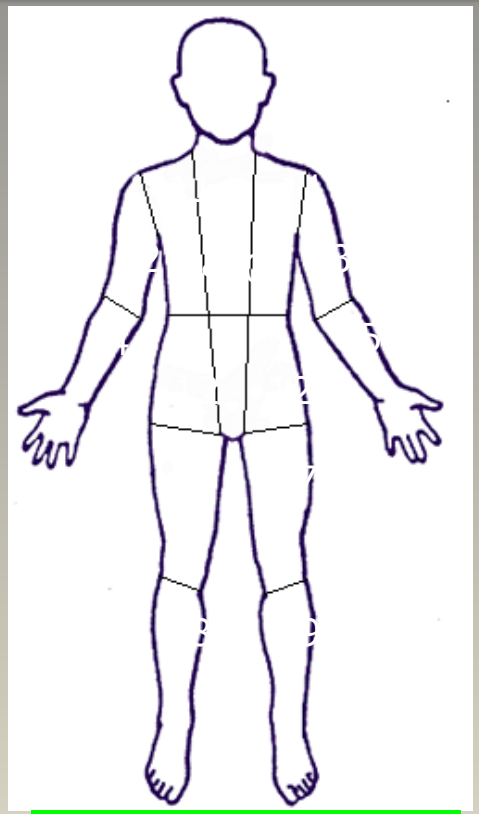
de la captación

de

MIBG

en

12 segmentos



SIOP-EN 2009

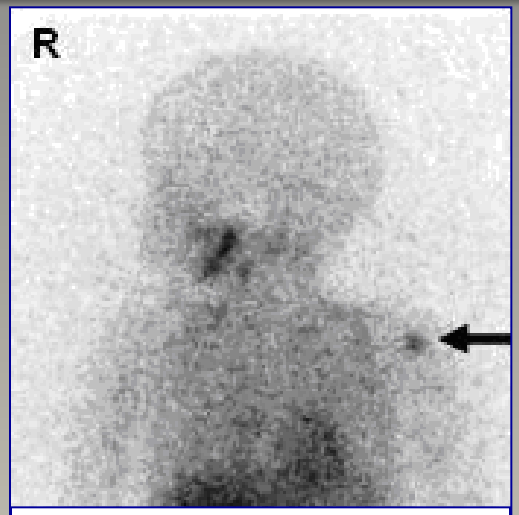
skull
thoracic cage
right humerus
left humerus
right radius/ulna
left radius/ulna
spine
pelvis
right femur
left femur
right tibia/fibula
left tibia/fibula

0 - 6 Extension	**score**
No abnormality	0
1 focal lesion	1
2 focal lesions	2
3 focal lesions	3
> 3 focal lesions or diffuse pattern involving < 50% of bone	4
Diffuse pattern involving > 50 – 95% of bone	5
Diffuse involving whole bone	6
Soft tissue involvement	

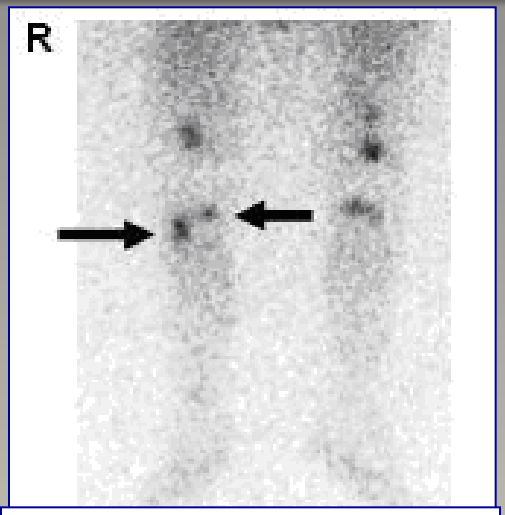
Valor máximo Score SIOPEN: 72

SIOP-EN: hoja de recogida de datos

International Society of Paediatric Oncology – European Neuroblastoma



Húmero izquierdo: 1



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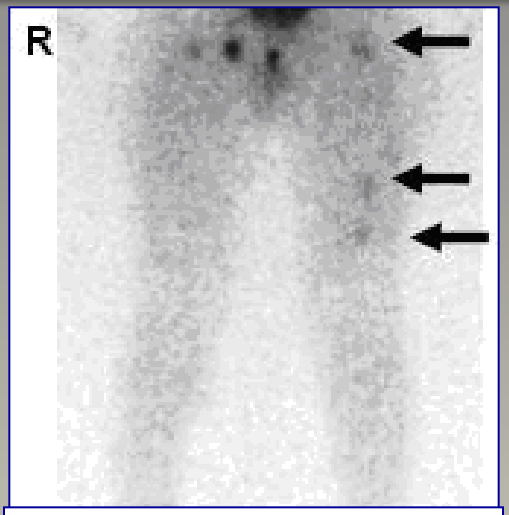
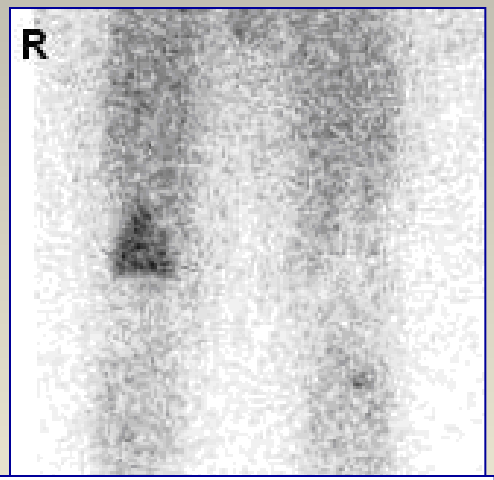


Fémur izquierdo: 3



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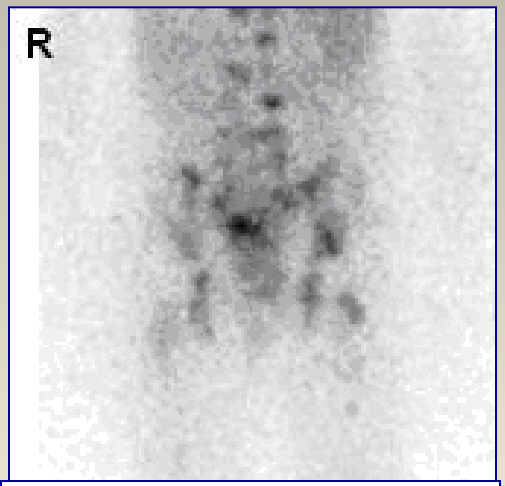
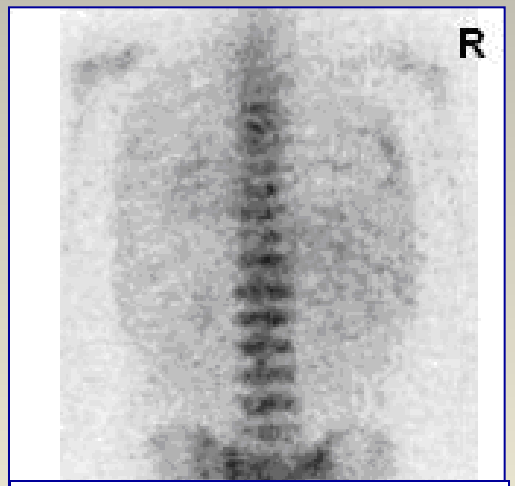


Pelvis: 5



Columna: 6

- Diagnostic mIBG scoring
  Referee: Catia OLIANTI (catia.olianti@unifi.it)

Score simplificado: menos áreas, valoración de 0 a 3 por área

- NBL PET imaging (18F-DOPA, 68GA-DOTA-peptides)
  Referee: Bart De KEIZER (b.dekeizer@umcutrecht.nl)

Incorporar los nuevos fármacos PET a la valoración metabólica del NBL

- Additional value of SUV in mIBG SPECT/CT imaging
  Referee: Matt ALDRIDGE (matthewaldridge@nhs.net)

Incorporar SPECT y SPECT-TC al score cuantitativo

- Update on new SIOPEN protocols concerning NBL therapy
  Referee: Julia BALAGUER (balaguer_jul@gva.es)
- Ongoing SIOPEN protocols concerning NBL NM therapy
  Referee: Hélène GAUTHIER (h-gauthier@o-lambret.fr)
- Dosimetry for NBL NM therapy
  Referee: Matt ALDRIDGE (matthewaldridge@nhs.net)
- Regular update on literature reports concerning NBL
  Referee: Giulia Anna FOLLACCHIO.

SIOPEN autumn meeting Jerusalem October 10-12, 2018
Minutes of the meeting of Nuclear Medicine&Physics Specialty Committee
October 10th, 2018

SIOPEN autumn meeting Jerusalem October 10-12, 2018
Minutes of the informal meeting of Nuclear Medicine&Physics Specialty Committee
October 11th, 2018

Minutes of the informal meeting of Nuclear Medicine&Physics Specialty Committee EANM Annual Congress, Dusseldorf
October 14th, 2018

Catia Olianti, referee for **"Diagnostic mIBG scoring"** working group, reported on:

- a proposal for a modified SIOPEN score, characterized by a reduced number of body segments and a reduced range of lesion scoring. A retrospective evaluation of this modified SIOPEN score could be performed on HR-NBL1/COG population in comparison to SIOPEN and Curie scores;

Bart de Keizer, referee for **"NBL PET imaging"** working group, reported on two studies ongoing in Utrecht centre:

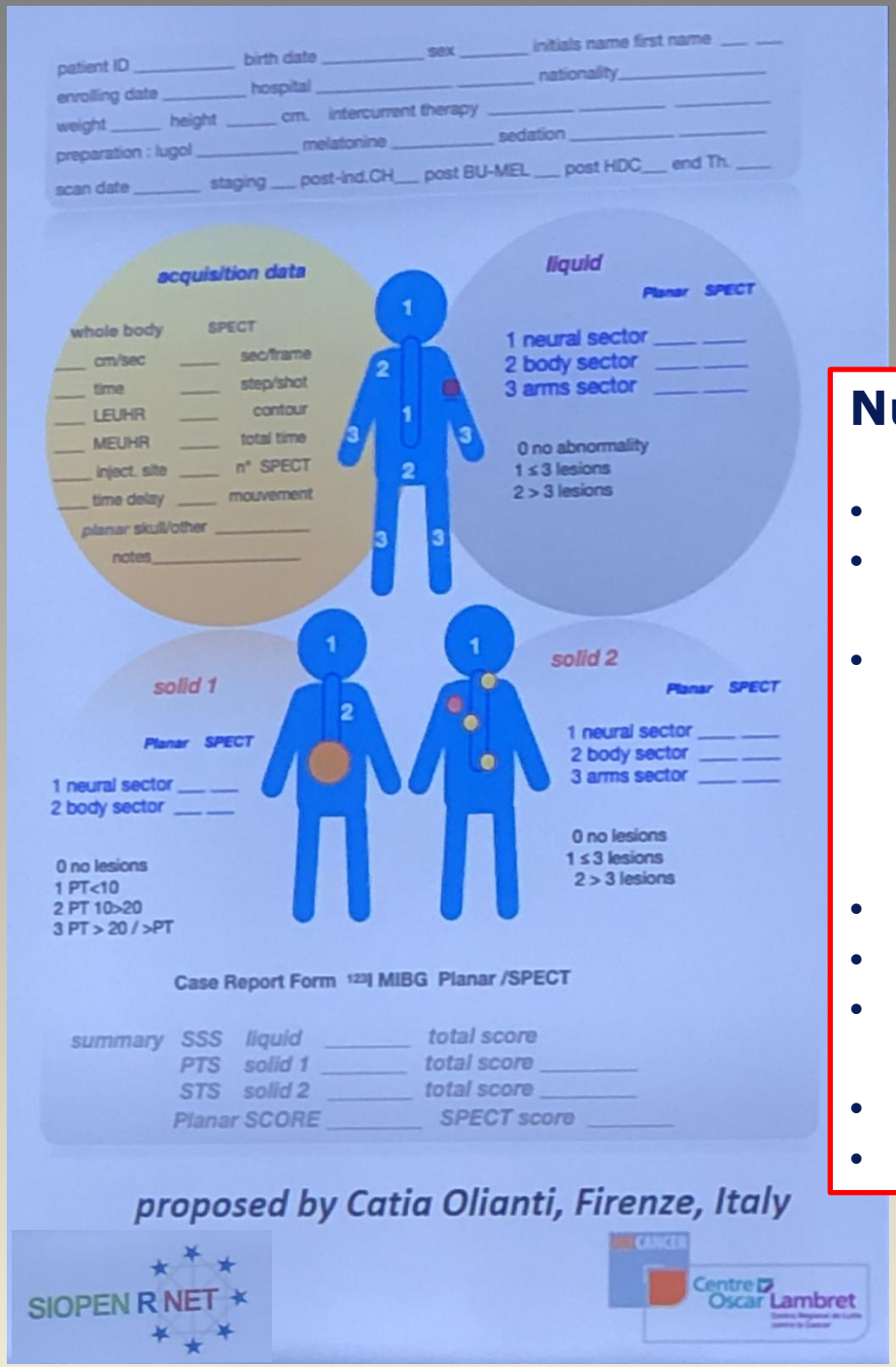
- Prospective comparison of the newly synthetized PET tracer 18F-MFBG *vs* SPET tracer 123I-mIBG: due to the high-quality imaging results obtained in a preliminary evaluation of this compound, Utrecht NM centre could help other SIOPEN NM centres for the in-house development of this tracer;
- Retrospective comparison of 123I-mIBG imaging *vs* 18F-FDG PET imaging in NB patients;
- Proposal for the creation of a European database to store and evaluate 123I-mIBG and 18F-FDG PET images from active SIOPEN Nuclear Medicine centres.

SIOPEN Spring meeting

Prague, May 23-24, 2019

Minutes of the meeting of Nuclear Medicine &Physics Specialty Committee

May 23rd, 2019, 14:30-16:00



mIBG modified scoring system

- Proposal for a modified SIOPEN score: retrospective analysis of local cohorts vs SIOPEN score to evaluate clinical impact

Nuevo score SIOPEN:

- planar y SPECT
- Incluye partes blandas

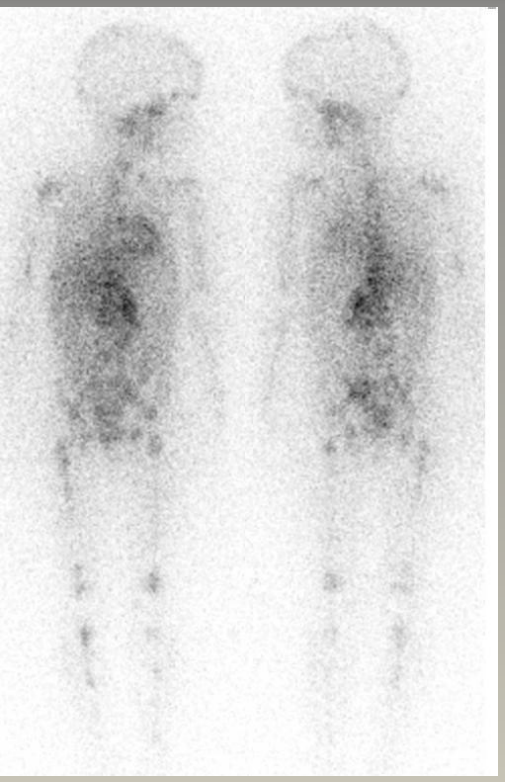
- 3 sectores:
  - Neural: craneo y medula espinal
  - Body
  - Extremidades

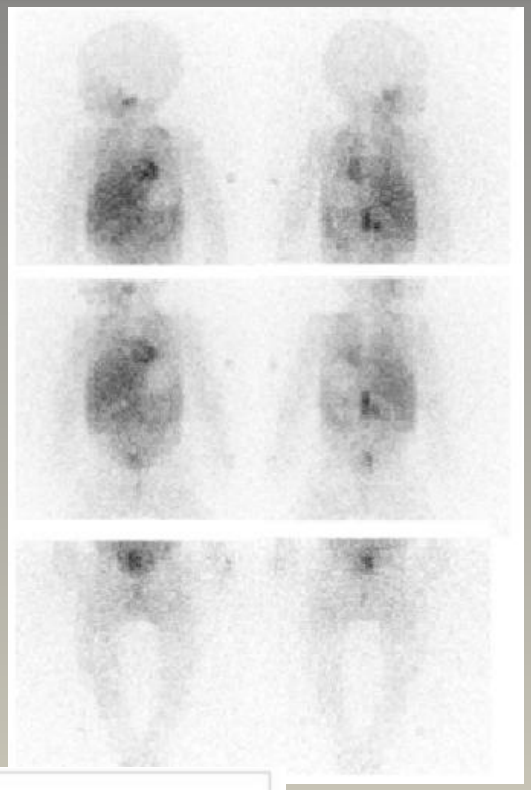
- 0 = no lesiones
- 1 = 1-2 lesiones
- 2 = > 3 lesiones

- Planar Score
- SPECT Score

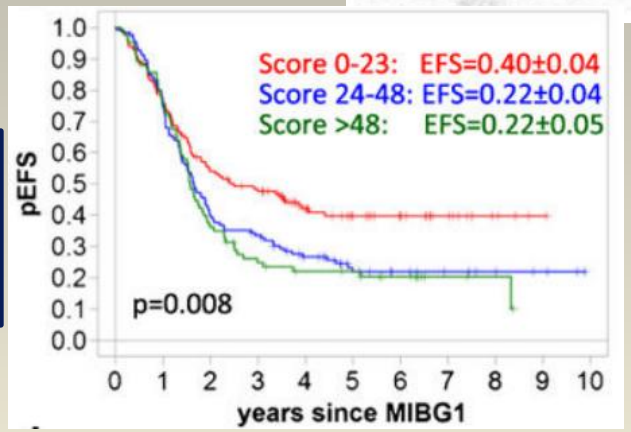
SIOPEN Autumn Meeting October 14 2019
EANM, Barcelona

MIBG – valoración al diagnóstico



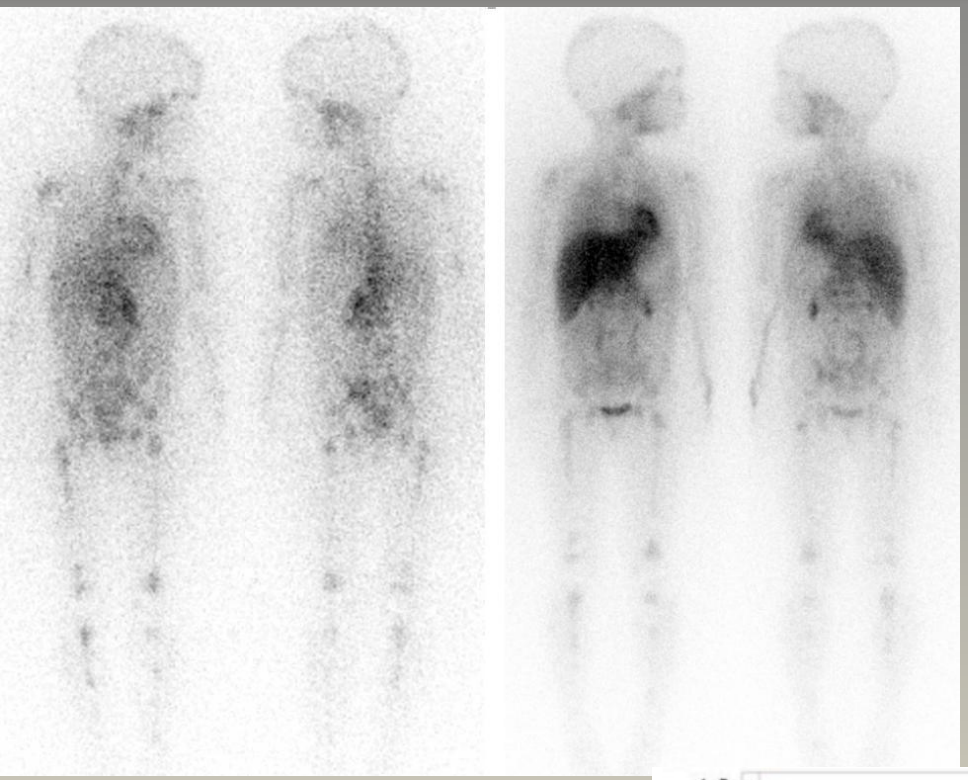


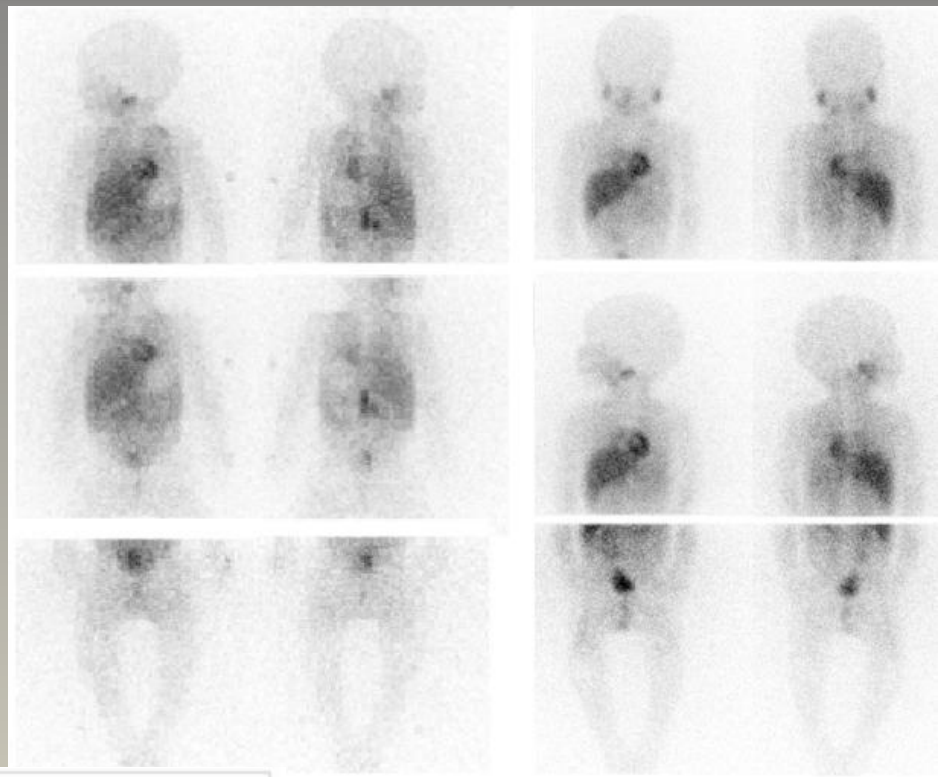
Score SIOPEN
al diagnóstico
< 23



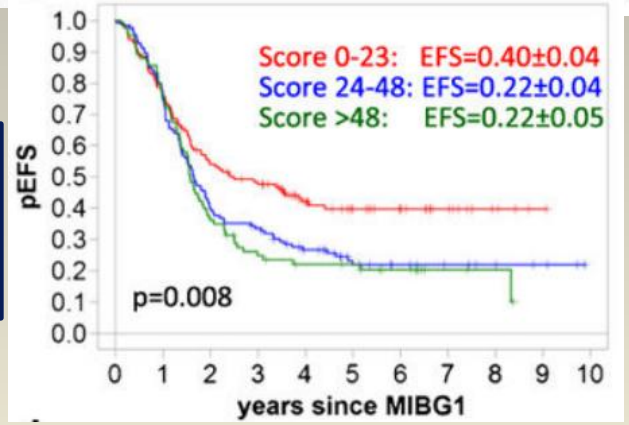
Ladenstein R, Lambert B, Pötschger U, Castellani MR, Lewington V, Bar-Sever Z, Oudoux A, Śliwińska A, Taborska K, Biassoni L, Yanik GA, Naranjo A, Parisi MT, Shulkin BL, Nadel H, Gelfand MJ, Matthay KK, Park JR, Kreissman SG, Valteau-Couanet D, Boubaker A. Validation of the mIBG skeletal SIOPEN scoring method in two independent high risk neuroblastoma populations: the SIOPEN/HR-NBL1 and COG-A3973 trials. Eur J Nucl Med Mol Imaging. 2018 Feb;45(2):292-305.

MIBG – valoración respuesta post inducción



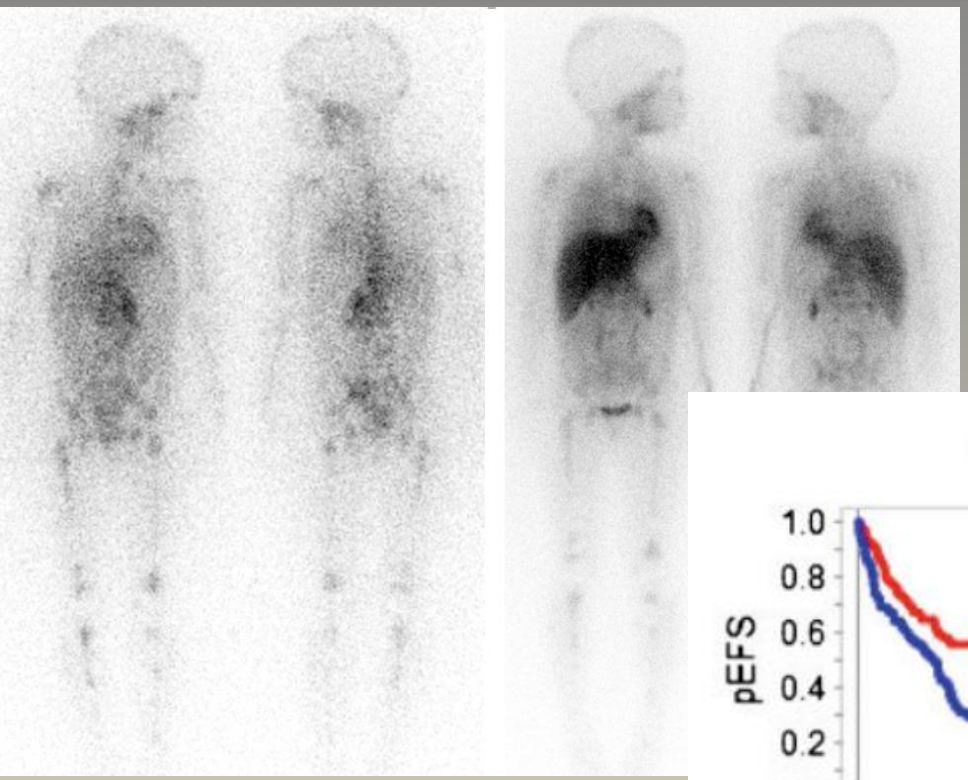


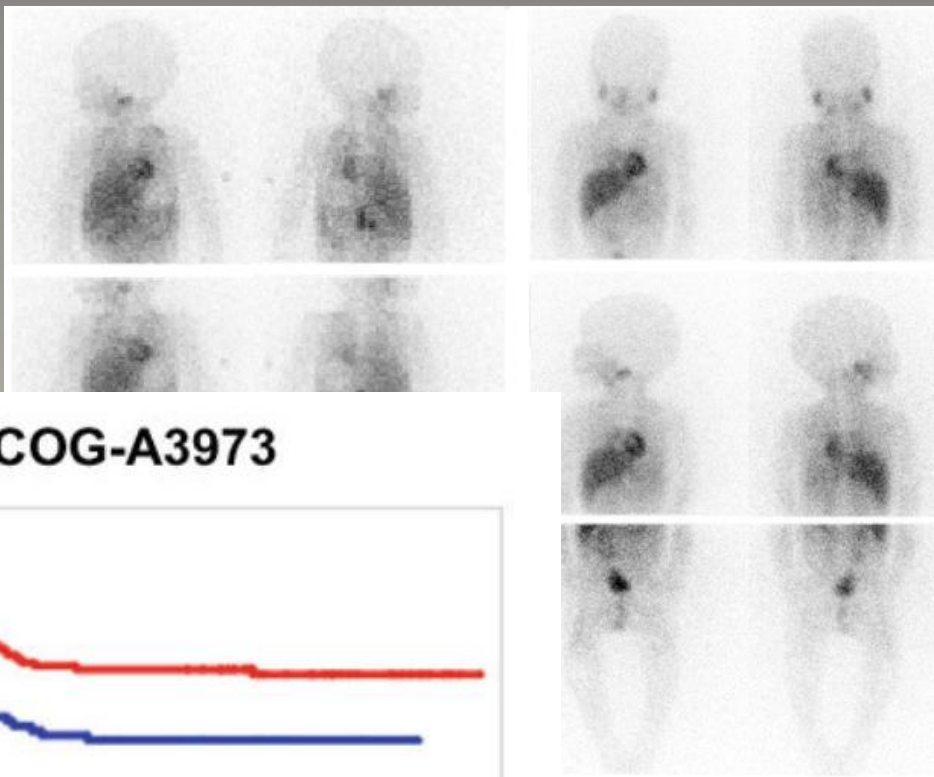
Score SIOPEN
al diagnóstico
< 23



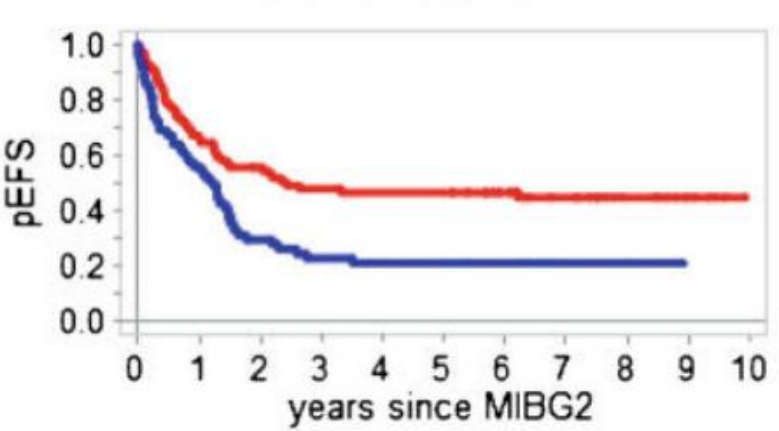
Ladenstein R, Lambert B, Pötschger U, Castellani MR, Lewington V, Bar-Sever Z, Oudoux A, Śliwińska A, Taborska K, Biassoni L, Yanik GA, Naranjo A, Parisi MT, Shulkin BL, Nadel H, Gelfand MJ, Matthay KK, Park JR, Kreissman SG, Valteau-Couanet D, Boubaker A. Validation of the mIBG skeletal SIOPEN scoring method in two independent high risk neuroblastoma populations: the SIOPEN/HR-NBL1 and COG-A3973 trials. Eur J Nucl Med Mol Imaging. 2018 Feb;45(2):292-305.

MIBG – valoración respuesta post inducción





Comparación Score SIOPEN diagnóstico – postinducción = 0

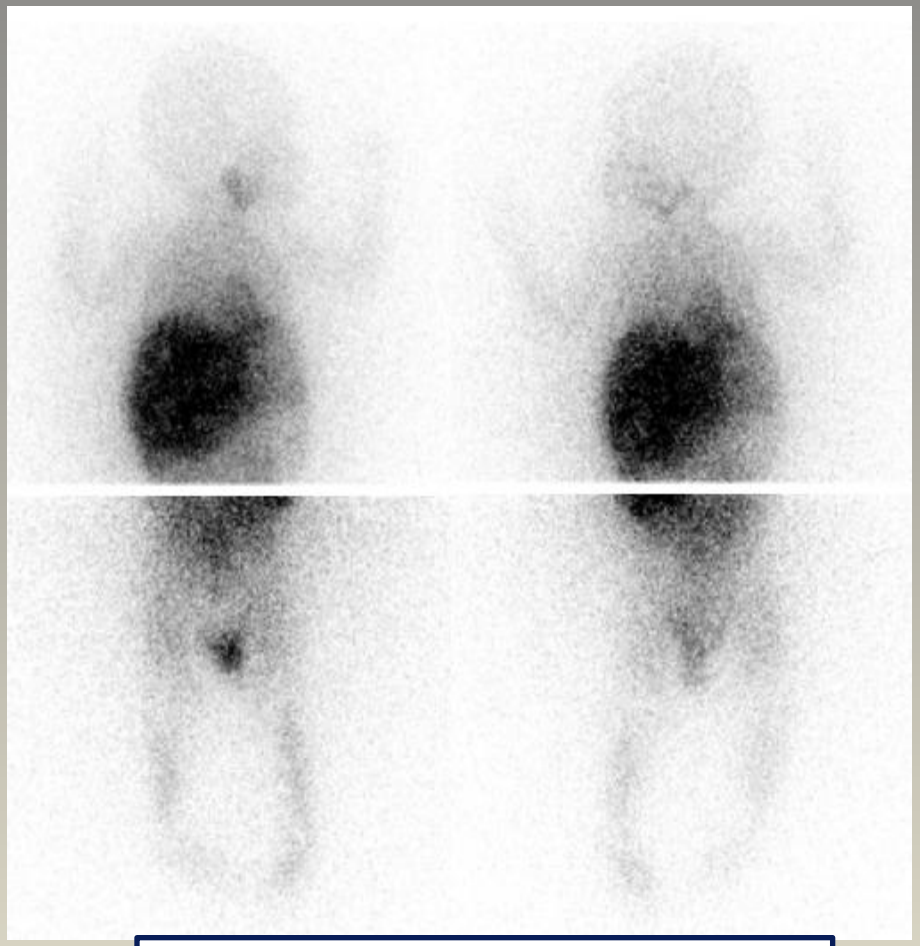


Score post	Events/ pts	5-yrs. pEFS	p-value
=0	43/79	0.47±0.06	0.003
>0	48/61	0.21±0.05	

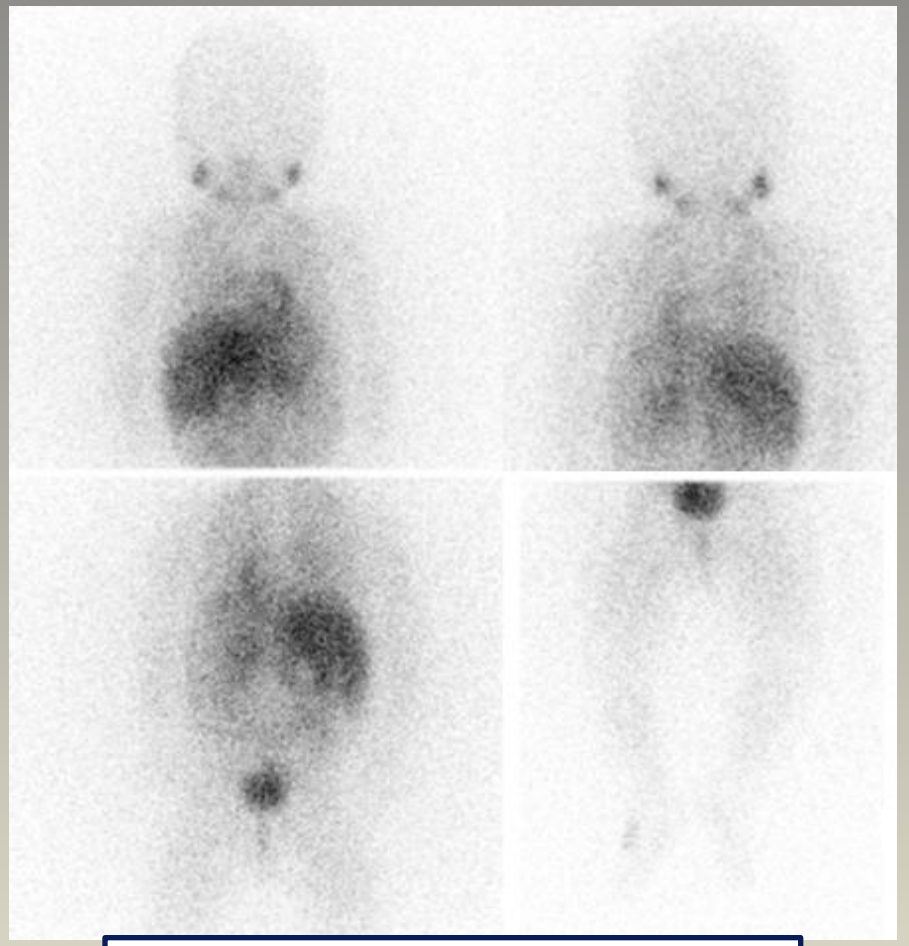
Ladenstein R, Lambert B, Pötschger U, Castellani MR, Lewington V, Bar-Sever Z, Oudoux A, Śliwińska A, Taborska K, Biassoni L, Yanik GA, Naranjo A, Parisi MT, Shulkin BL, Nadel H, Gelfand MJ, Matthay KK, Park JR, Kreissman SG, Valteau-Couanet D, Boubaker A. Validation of the mIBG skeletal SIOPEN scoring method in two independent high risk neuroblastoma populations: the SIOPEN/HR-NBL1 and COG-A3973 trials. Eur J Nucl Med Mol Imaging. 2018 Feb;45(2):292-305.

NEUROBLASTOMA 4s

Neonato con anemia severa y insuficiencia hepática



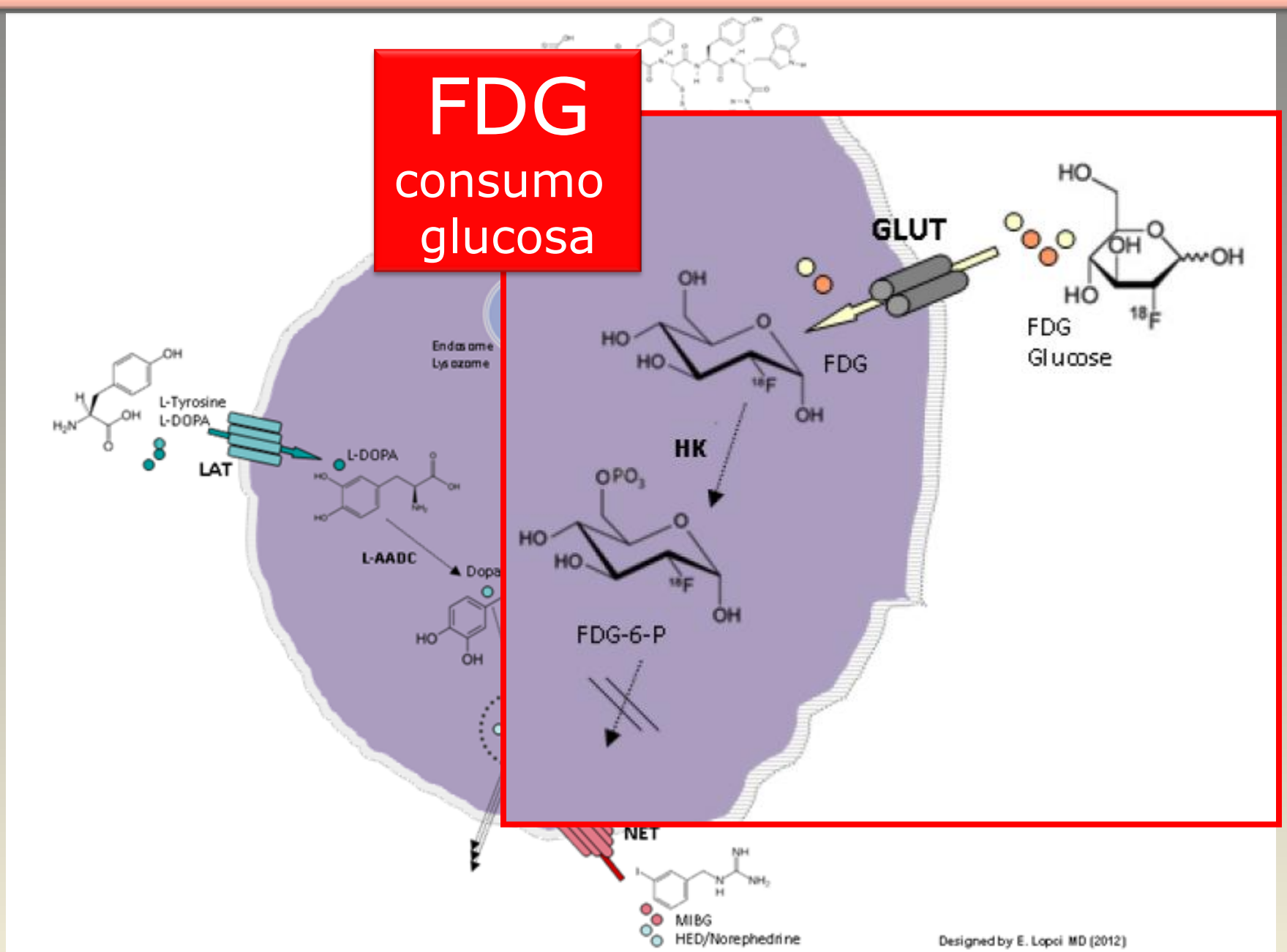
MIBG al diagnóstico



MIBG 2 m QT

No score SIOPEN

IMAGEN MOLECULAR en el NEUROBLASTOMA



SENSIBILIDAD FDG AL DIAGNÓSTICO O EN RECURRENCIA

Objective 2.1 Diagnostic accuracy of ^{18}F-FDG-PET(-CT) imaging for detecting a neuroblastoma and its metastases at first diagnosis or at recurrence

Patients/population: children from 0 to 18 years old with a neuroblastoma of any stage at first diagnosis or at recurrence.

Setting: tertiary care centres of paediatric oncology.

Index test: ^{18}F-FDG-PET(-CT) imaging.

Reference test: gold standard is histopathology and or bone marrow biopsies/trephine biopsies, but that was not always performed; so also: histopathology during or after treatment (e.g. tissue obtained during surgery), if urinary metabolites were elevated at diagnosis and additional imaging modalities (e.g. ultrasound, CT scan, MRI scan) suggested a neuroblastoma at diagnosis.

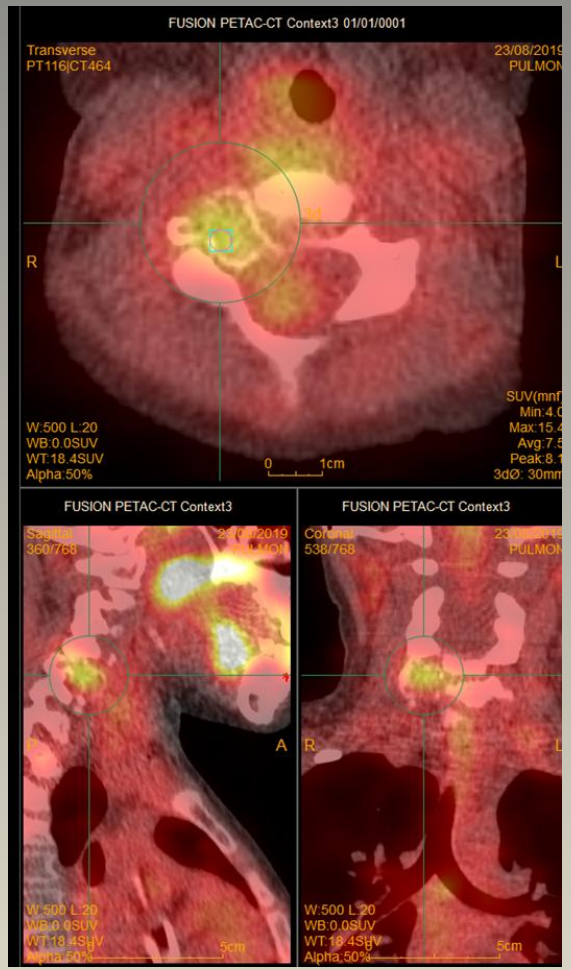
Studies: retrospective cohort study

Subgroup	Second covariate	Sensitivity	Specificity	Number of participants (studies)
Neuroblastoma (all stages) at first diagnosis	—	1.00	a	24 (1 study)
Stage 1 and 2	—	1.00	a	5 (1 study)
Stage 3	—	1.00	a	3 (1 study)
Stage 4	—	1.00	a	16 (1 study)

La sensibilidad de FDG es muy alta tanto al diagnóstico como en recurrencia en todas las series publicadas

Bleeker G, Tytgat GA, Adam JA, Caron HN, Kremer LC, Hooft L, van Dalen EC. 123I-MIBG scintigraphy and 18F-FDG-PET imaging for diagnosing neuroblastoma. Cochrane Database Syst Rev. 2015 Sep 29;(9):CD009263.

^{18}F-FDG PET-TC



FDG detecta las células cancerosas con **mayor** grado metabólico

Proporciona información oncológica sobre el **grado metabólico** de la enfermedad neoplásica

En el NEUROBLASTOMA:

- diferentes áreas tumorales captan radiofármacos diferentes
- los NBL captan FDG antes de la terapia citoreductora
- durante y después de la terapia la captación es variable

Se ha descrito la **utilidad** de **FDG-PET** en:

- neuroblastoma con baja o sin captación de MIBG
- pérdida de la captación de MIBG durante el tratamiento
- en los momentos de decisiones cruciales en el curso de la enfermedad

^{18}F-FDG PET-TC vs ^{123}I-MIBG

^{123}I-MIBG Scintigraphy and ^{18}F-FDG PET in Neuroblastoma

Susan E. Sharp[1], Barry L. Shulkin[2], Michael J. Gelfand[1], Shelia Salisbury[3], and Wayne L. Furman[4]

[1]Department of Radiology, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; [2]Department of Radiological Sciences, St. Jude Children's Research Hospital, Memphis, Tennessee; [3]Department of Biostatistics and Epidemiology, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; and [4]Department of Oncology, St. Jude Children's Research Hospital, Memphis, Tennessee

Sharp SE, Shulkin BL, Gelfand MJ, Salisbury S, Furman WL. 123I-MIBG scintigraphy and 18F-FDG PET in neuroblastoma. J Nucl Med. 2009 Aug;50(8):1237-43.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

N= 113 pares de estudios FDG-MIBG

TABLE 1. Summary of Results

Stage	Result			
	^{123}I-MIBG > ^{18}F-FDG	^{18}F-FDG > ^{123}I-MIBG	Equivalent	Negative
Stage 1 and 2 neuroblastoma (13 scans/10 patients*)				
Diagnosis	—	4 scans/4 pts	1 scan/1 pt	—
Follow-up	—	5 scans/3 pts	—	3 scans/3 pts
Total	—	9 scans/6 pts	1 scan/1 pt	3 scans/3 pts
Stage 3 neuroblastoma (15 scans/10 patients*)				
Diagnosis	—	1 scan/1 pt	2 scans/2 pts	—
Follow-up	5 scans/4 pts	3 scans/3 pts	—	4 scans/3 pts
Total	5 scans/4 pts	4 scans/4 pts	2 scans/2 pts	4 scans/3 pts
Stage 4 neuroblastoma (85 scans/40 patients*)				
Diagnosis	8 scans/8 pts	3 scans/3 pts	5 scans/5 pts	—
Follow-up ≤ 12 months	19 scans/12 pts	5 scans/3 pts	5 scans/5 pts	6 scans/5 pts
Follow-up > 12 months	17 scans/10 pts	3 scans/3 pts	3 scans/3 pts	11 scans/10 pts
Total	44 scans/24 pts	11 scans/8 pts	13 scans/11 pts	17 scans/14 pts

*Patients with more than 1 scan during study period may be listed in different categories (i.e., patients scanned at both diagnosis and follow-up or patients with multiple follow-up scans with different results).

^{123}I-MIBG > ^{18}F-FDG = numbers of scans and patients for which ^{123}I-MIBG detected more lesions; pts = patients; ^{18}F-FDG > ^{123}I-MIBG = numbers of scans and patients for which ^{18}F-FDG detected more lesions; Equivalent = numbers of scans and patients for which ^{123}I-MIBG and ^{18}F-FDG detected similar or complementary numbers and distributions of lesions; Negative = numbers of scans and patients for which ^{123}I-MIBG and ^{18}F-FDG study results were normal.

Sharp SE, Shulkin BL, Gelfand MJ, Salisbury S, Furman WL. 123I-MIBG scintigraphy and 18F-FDG PET in neuroblastoma. J Nucl Med. 2009 Aug;50(8):1237-43.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

Stage	^{123}I-MIBG > ^{18}F-FDG	^{18}F-FDG > ^{123}I-MIBG
Stage 1 and 2 neuroblastoma (13 scans/10 patients*)		
Diagnosis	—	4 scans/4 pts
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^{18}F-FDG PET-TC vs ^{123}I-MIBG

Stage	^{123}I-MIBG > ^{18}F-FDG	^{18}F-FDG > ^{123}I-MIBG
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^{18}F-FDG PET-TC vs ^{123}I-MIBG

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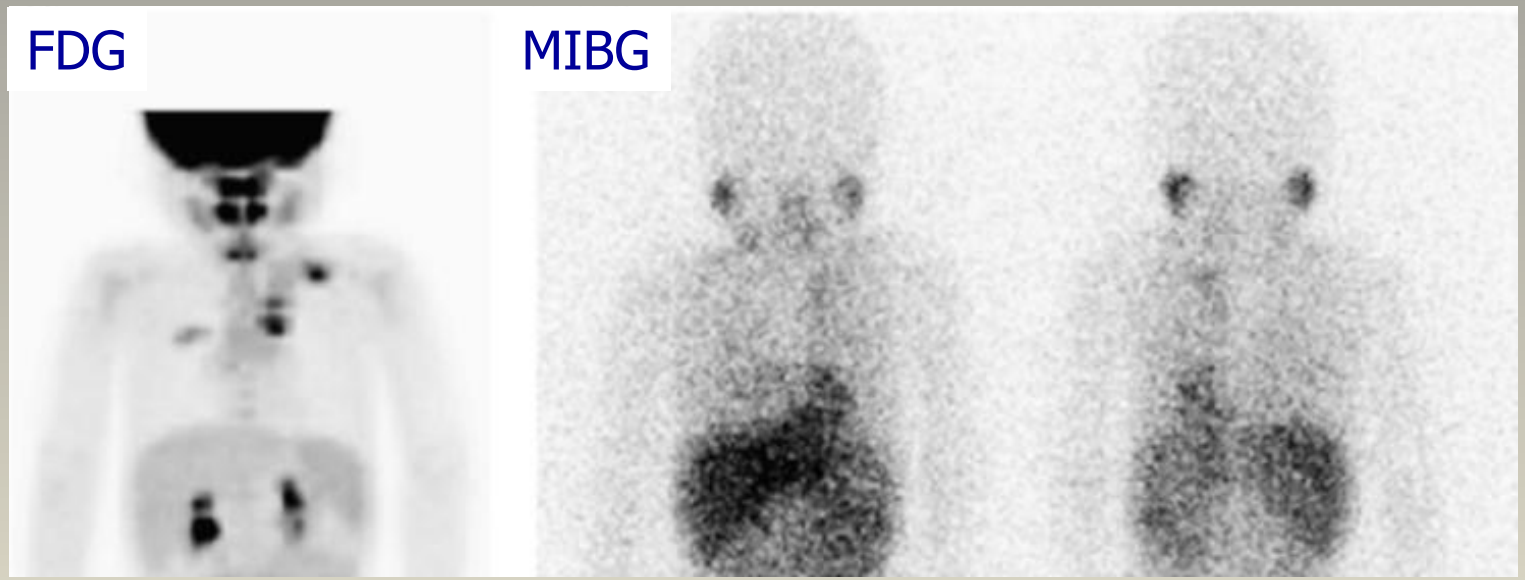
^{18}F-FDG PET-TC vs ^{123}I-MIBG

NEUROBLASTOMA estadío II

3 años

MIBG detecta menos lesiones que FDG

MIBG < FDG



Sharp SE, Shulkin BL, Gelfand MJ, Salisbury S, Furman WL. 123I-MIBG scintigraphy and 18F-FDG PET in neuroblastoma. J Nucl Med. 2009 Aug;50(8):1237-43.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

NEUROBLASTOMA estadío III

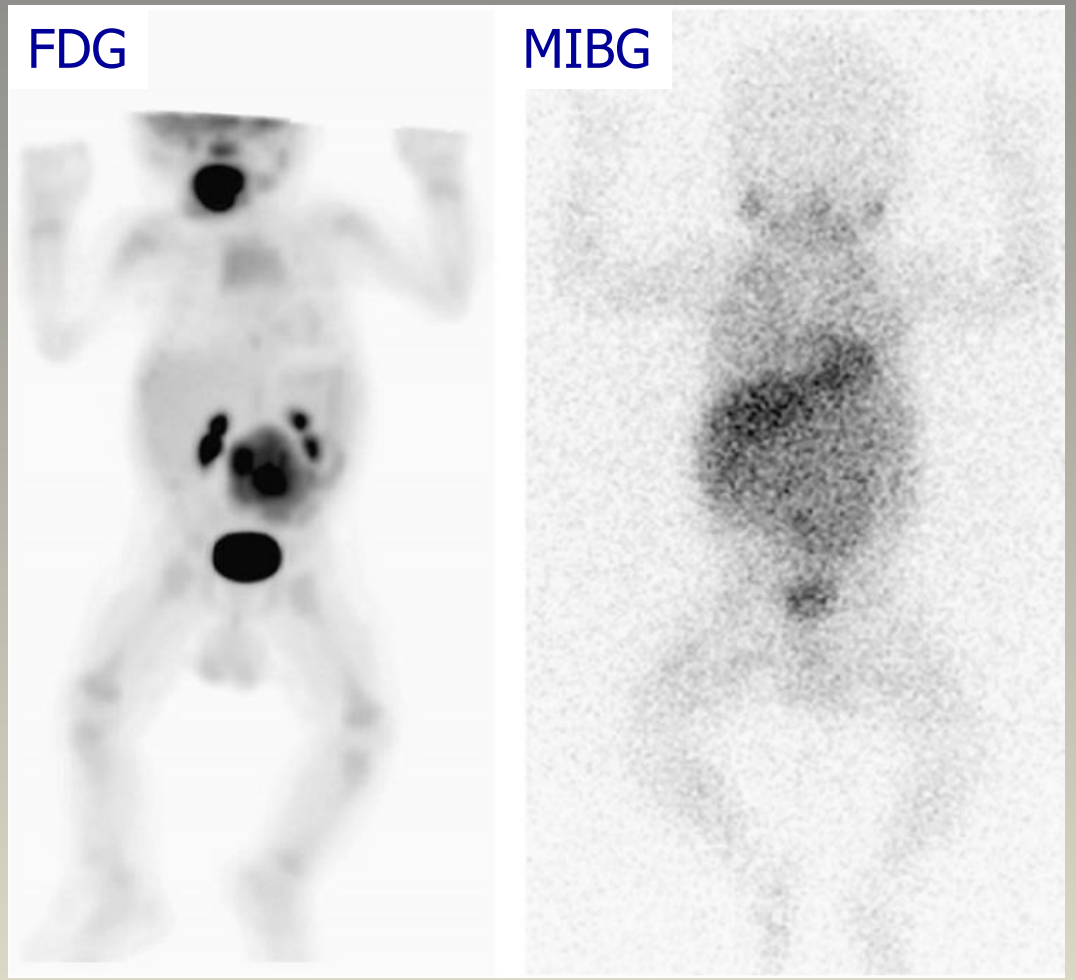
3 meses

diagnóstico

FDG: intensa captación Tm y leve actividad medular ósea

MIBG: mínima actividad en tumor abdominal

MIBG FN



Sharp SE, Shulkin BL, Gelfand MJ, Salisbury S, Furman WL. 123I-MIBG scintigraphy and 18F-FDG PET in neuroblastoma. J Nucl Med. 2009 Aug;50(8):1237-43.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

NEUROBLASTOMA estadío IV

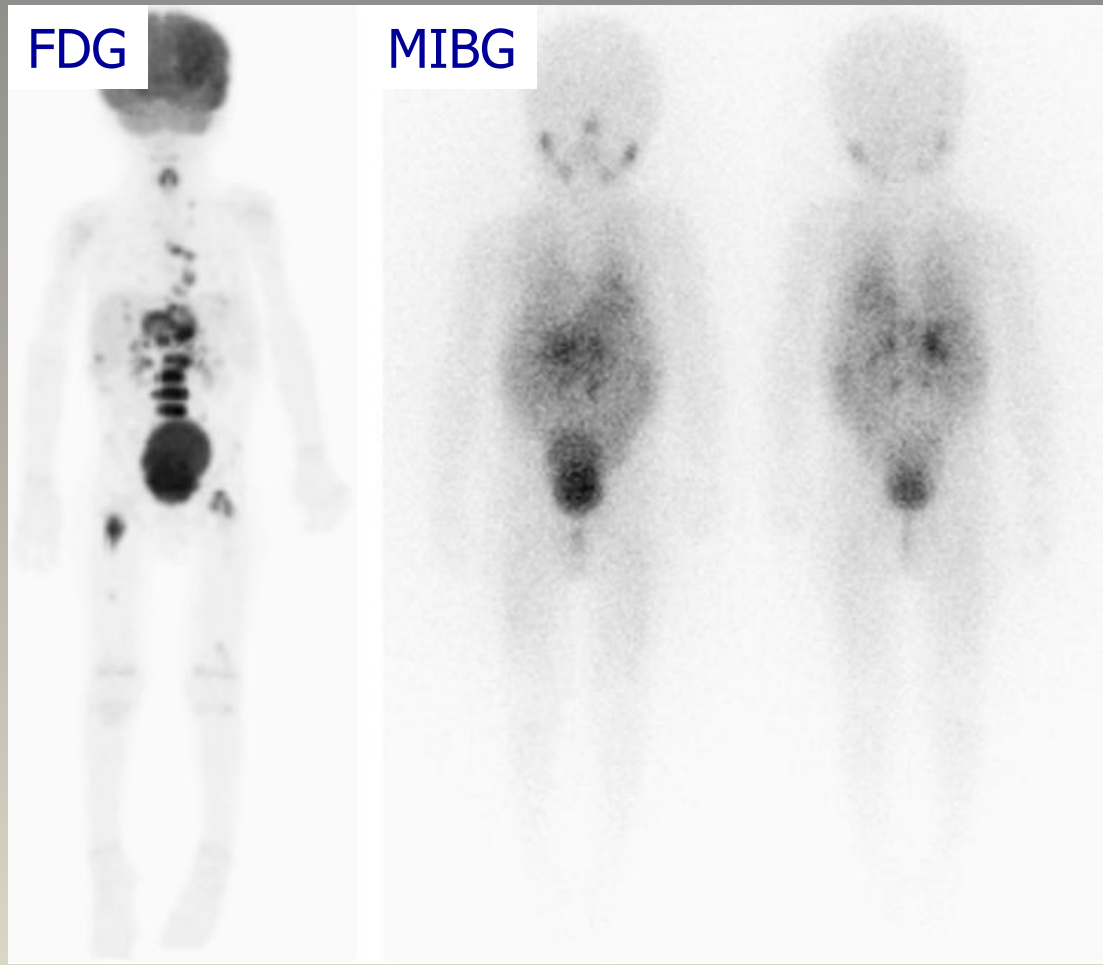
3 años

Evaluación pre-TMO

FDG: intensa captación en retroperitoneo, mediastino, huesos (+++vértebras y fémures)

MIBG: solo captación tm retroperitoneal

MIBG FN



Sharp SE, Shulkin BL, Gelfand MJ, Salisbury S, Furman WL. 123I-MIBG scintigraphy and 18F-FDG PET in neuroblastoma. J Nucl Med. 2009 Aug;50(8):1237-43.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

NEUROBLASTOMA estadío IV

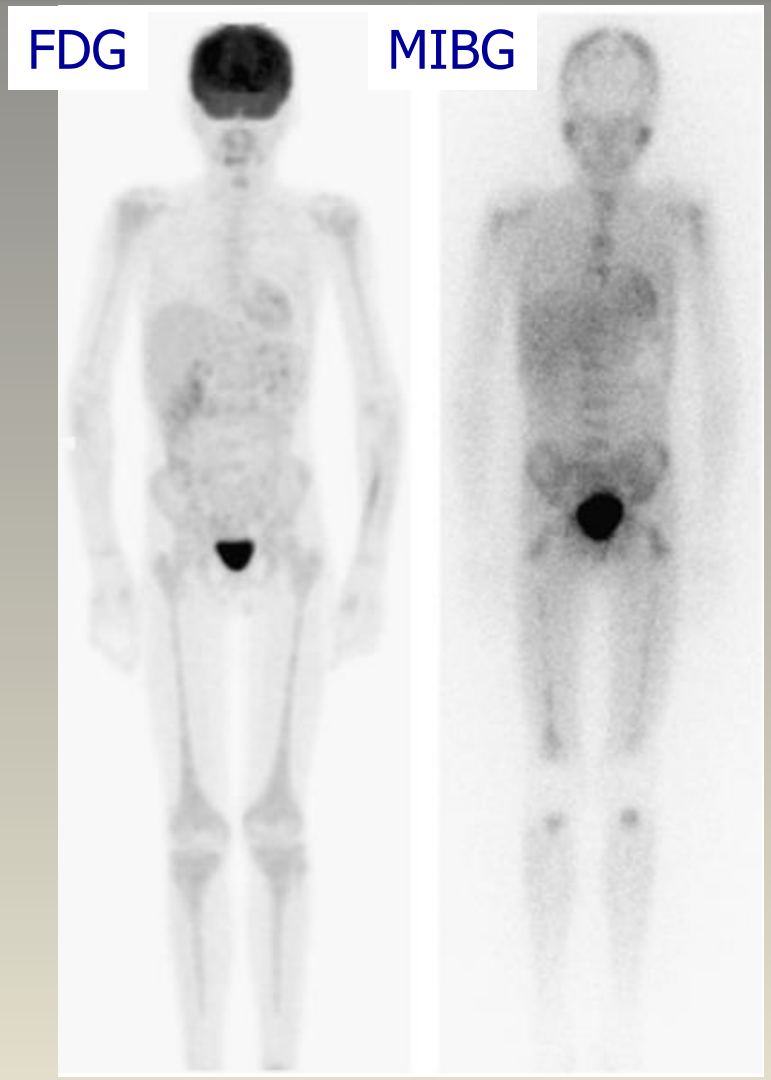
13 años

Evaluación precoz QT

FDG: captación leve ósea difusa en relación con factor estimulación colonias granulocíticas

MIBG: captación difusa ósea o medular ósea

FDG FN



Sharp SE, Shulkin BL, Gelfand MJ, Salisbury S, Furman WL. 123I-MIBG scintigraphy and 18F-FDG PET in neuroblastoma. J Nucl Med. 2009 Aug;50(8):1237-43.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

Eur J Nucl Med Mol Imaging
DOI 10.1007/s00259-011-1843-8

ORIGINAL ARTICLE

^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma

Henriette Ingrid Melzer · Eva Coppenrath · Irene Schmid · Michael H. Albert · Dietrich von Schweinitz · Coral Tudball · Peter Bartenstein · Thomas Pfluger

Melzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

Table 2 Lesion distribution according to stage, lesion diameter on MRI/CT, and false-negative findings

Stage	Diameter (cm)	Number of lesions	False-negative	
			^{123}I-MIBG scintigraphy	^{18}F-FDG PET
I (n=3)	1–2	1		
	2–5	1	2	0
	>5	1		
IIA (n=1)	2–5	1	0	1
III (n=4)	2–5	1		
	>5	3	1	1
IV (n=49)	<1	14		
	1–2	13		
	2–5	15	20	8
	>5	7		
Opsomyoclonus syndrome (n=1)	1–2	1	0	0

MIBG - FALSOS NEGATIVOS

N=23 lesiones / 58 pacientes

- hueso y medular con diámetro medio 1.7 cm
- columna vertebral
- pelvis
- fémur
- región paravertebral
- región adrenal

Melzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

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	>5	3		
IV (n=49)	<1	14		
	1–2	13		
	2–5	15	20	8
	>5	7		
Opsomyoclonus syndrome (n=1)	1–2	1	0	0

MIBG - FALSOS NEGATIVOS

N=23 lesiones / 58 pacientes

hueso y medular con diámetro medio 1.7 cm

columna vertebral

pelvis

fémur

región paravertebral

región adrenal

FDG - FALSOS NEGATIVOS

N=10 lesiones /58 pacientes

tumor adrenal

mets medulares en tibia, fémur, vértebra,

región presacra, retrocrural

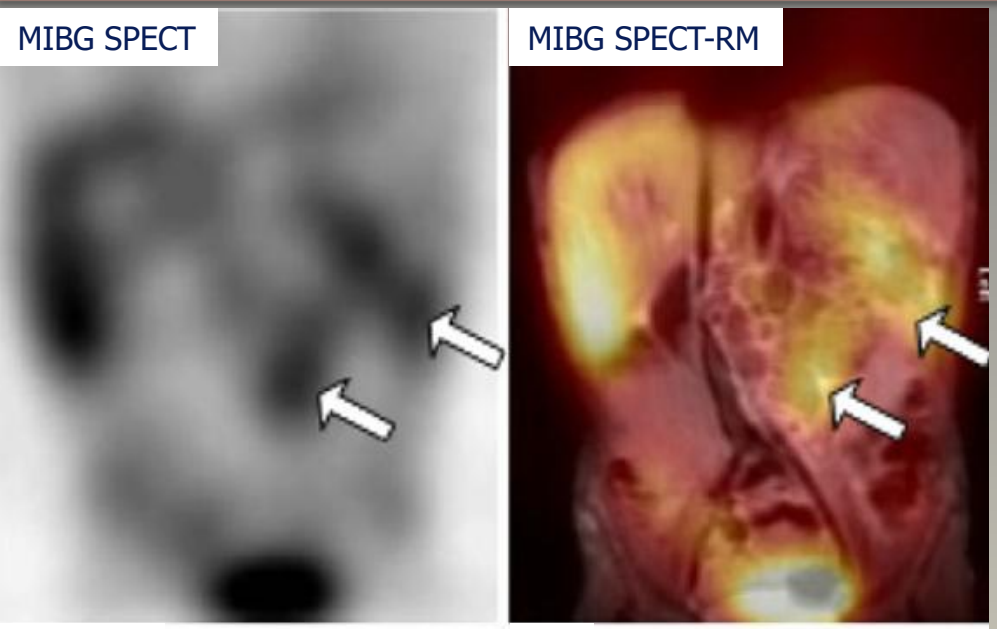
timo

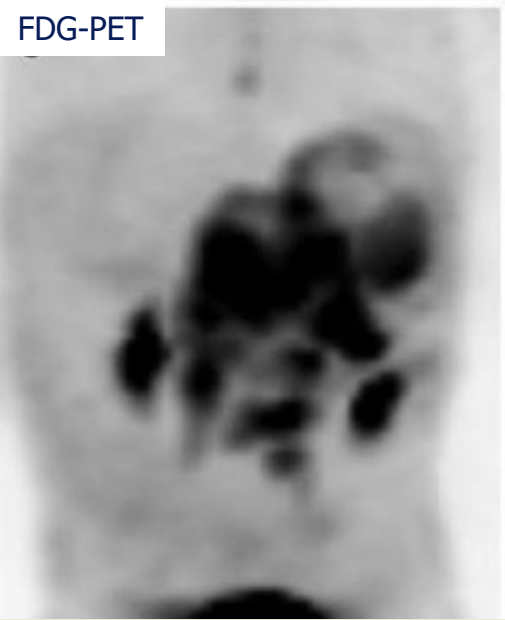
en 1 paciente estadío IIA (timo)

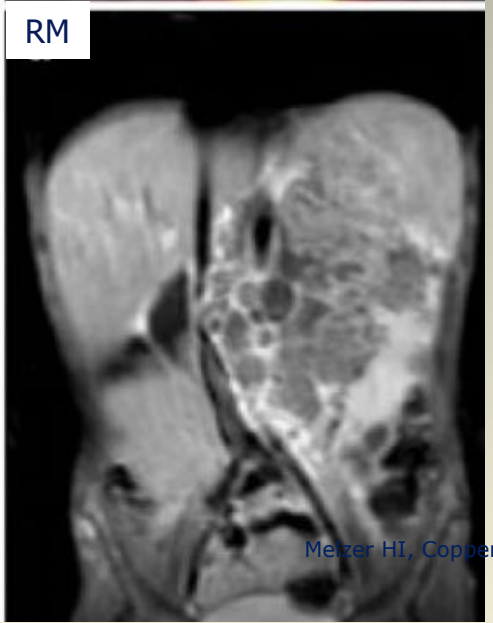
y en pacientes estadío IV

Melzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

^{18}F-FDG PET-TC vs ^{123}I-MIBG







NEUROBLASTOMA estadío IV

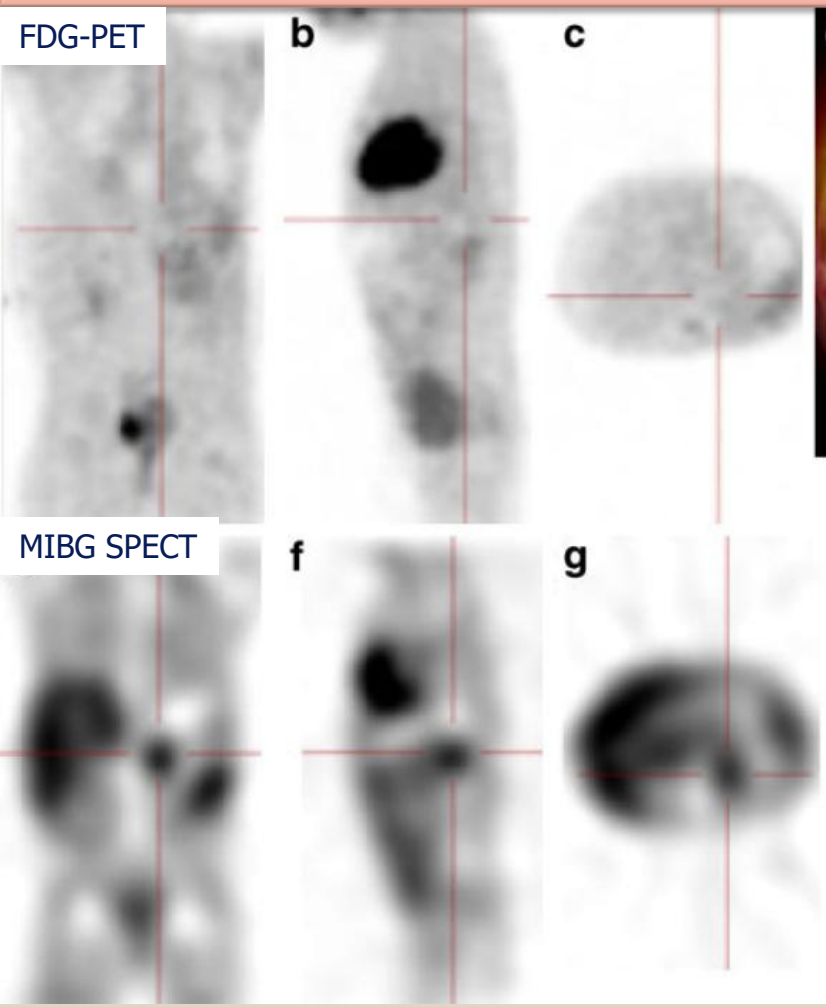
3,5 años

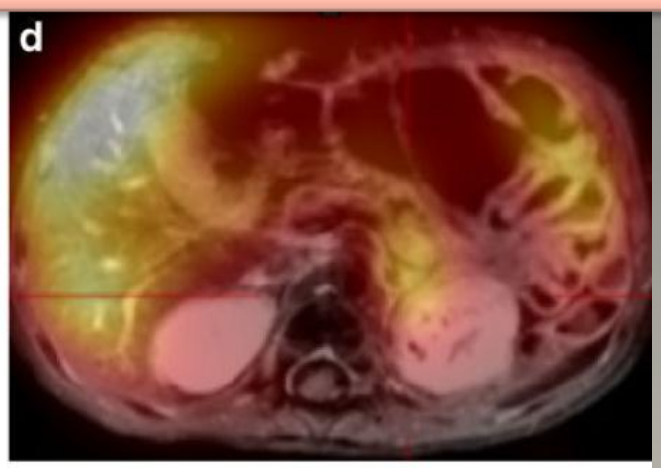
MIBG detecta menos lesiones que FDG y que RM

MIBG < FDG

Metzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

^{18}F-FDG PET-TC vs ^{123}I-MIBG





FDG FN?

NEUROBLASTOMA

2 años

Persistencia trás QT y cirugía

MIBG: persistencia tumoral en región suprarrenal izquierda

FDG: negativo

RM: cambios postquirúrgicos

Melzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

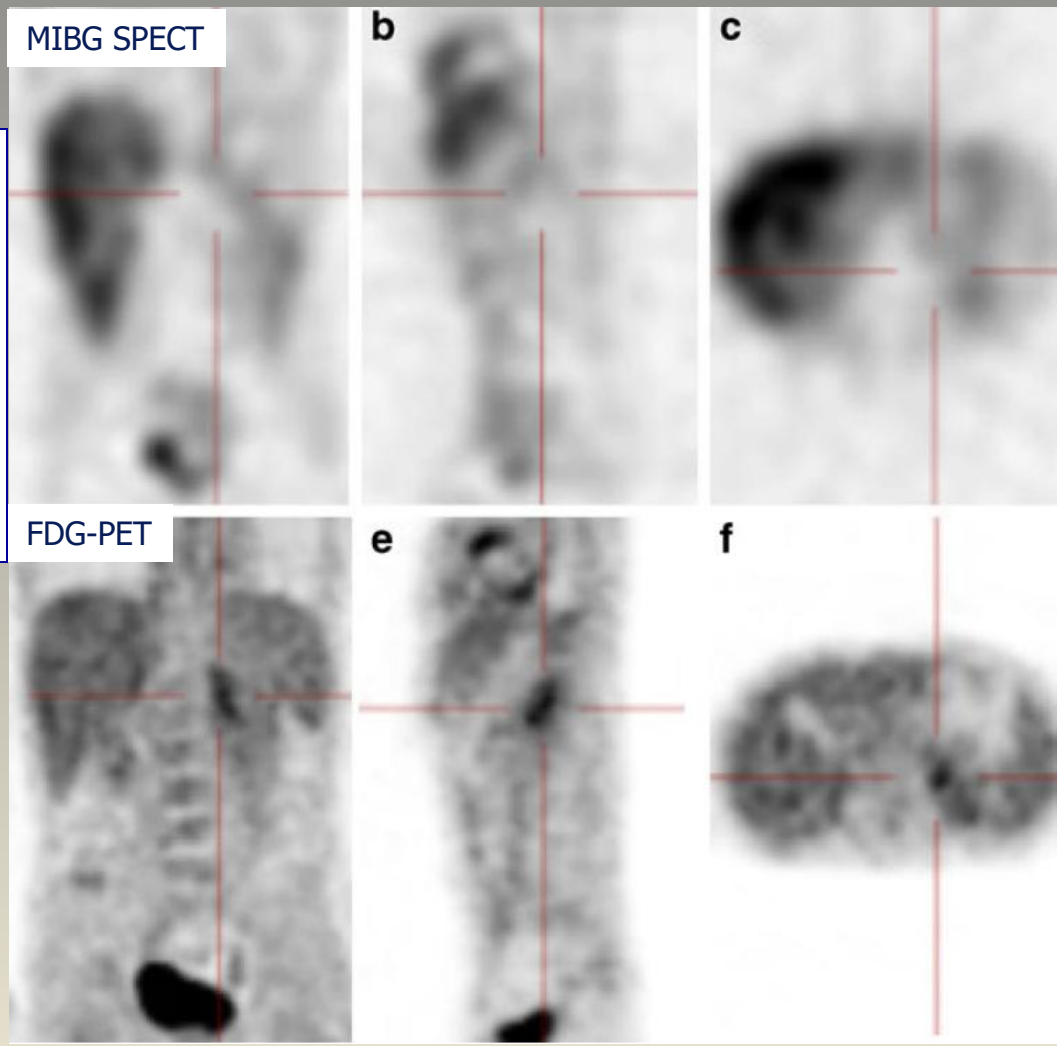
MIBG FN

NEUROBLASTOMA recurrencia

7 años

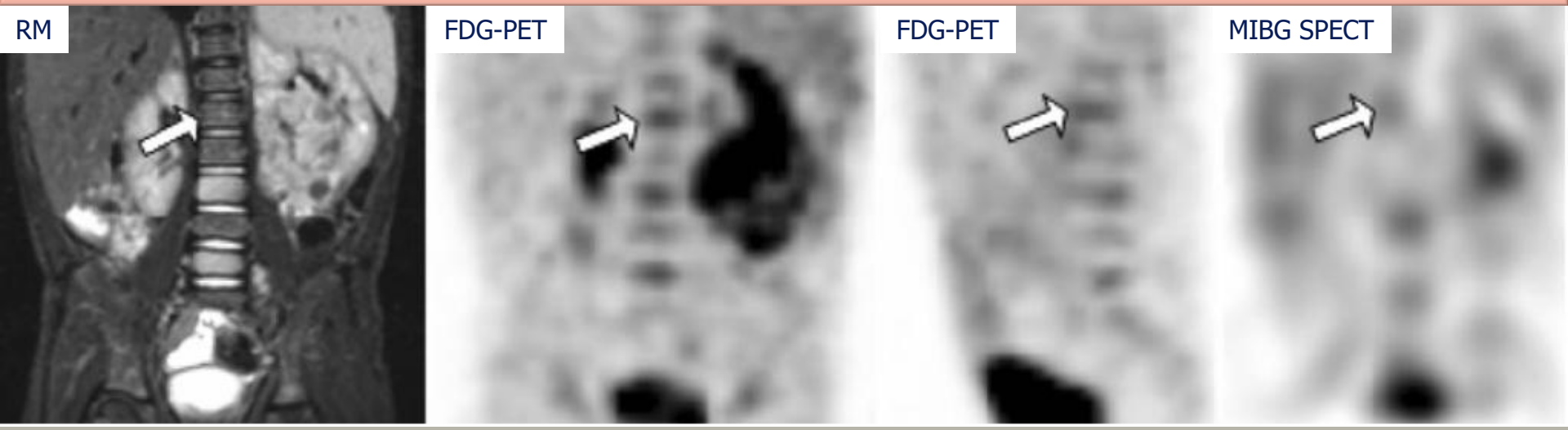
MIBG : FN en región suprarrenal izquierda

confirmación histopatológica



Melzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

^{18}F-FDG PET-TC vs ^{123}I-MIBG



NEUROBLASTOMA izquierdo

Estadificación inicial

4 años

RM: mets en L3 y L5. L1 normal

FDG: mets en L1, L3 y L5

MIBG: mets en L1, L3 y L5

RM FN

Melzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

^{18}F-FDG PET-TC vs ^{123}I-MIBG

- diferencias significativas en las captaciones de MIBG y FDG
- FDG: mayor sensibilidad para NEUROBLASTOMA con baja captación de MIBG
- recomiendan PET-FDG cuando existan discrepancias o resultados no concluyentes con MIBG (incluyendo SPECT) y las imágenes anatómicas

GLOBAL	MIBG	FDG-PET	MIBG y FDG	CT o RM
SENSIBILIDAD	50	78	85	93
ESPECIFICIDAD	75	92	92	25

SEGUIMIENTO	MIBG	FDG-PET	MIBG y FDG	CT o RM
SENSIBILIDAD	**48**	**64**	**90**	**100**
ESPECIFICIDAD	**82**	**91**	**91**	**18**

Melzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

^{18}F-FDG PET-TC - INDICACIONES

- MIBG INICIAL NEGATIVA
- NEGATIVIZACIÓN DE LA CAPTACIÓN DE MIBG
- MOMENTOS "CRÍTICOS" DEL TRATAMIENTO
- DISCORDANCIAS CLINICO-RADIOLOGICAS CON MIBG

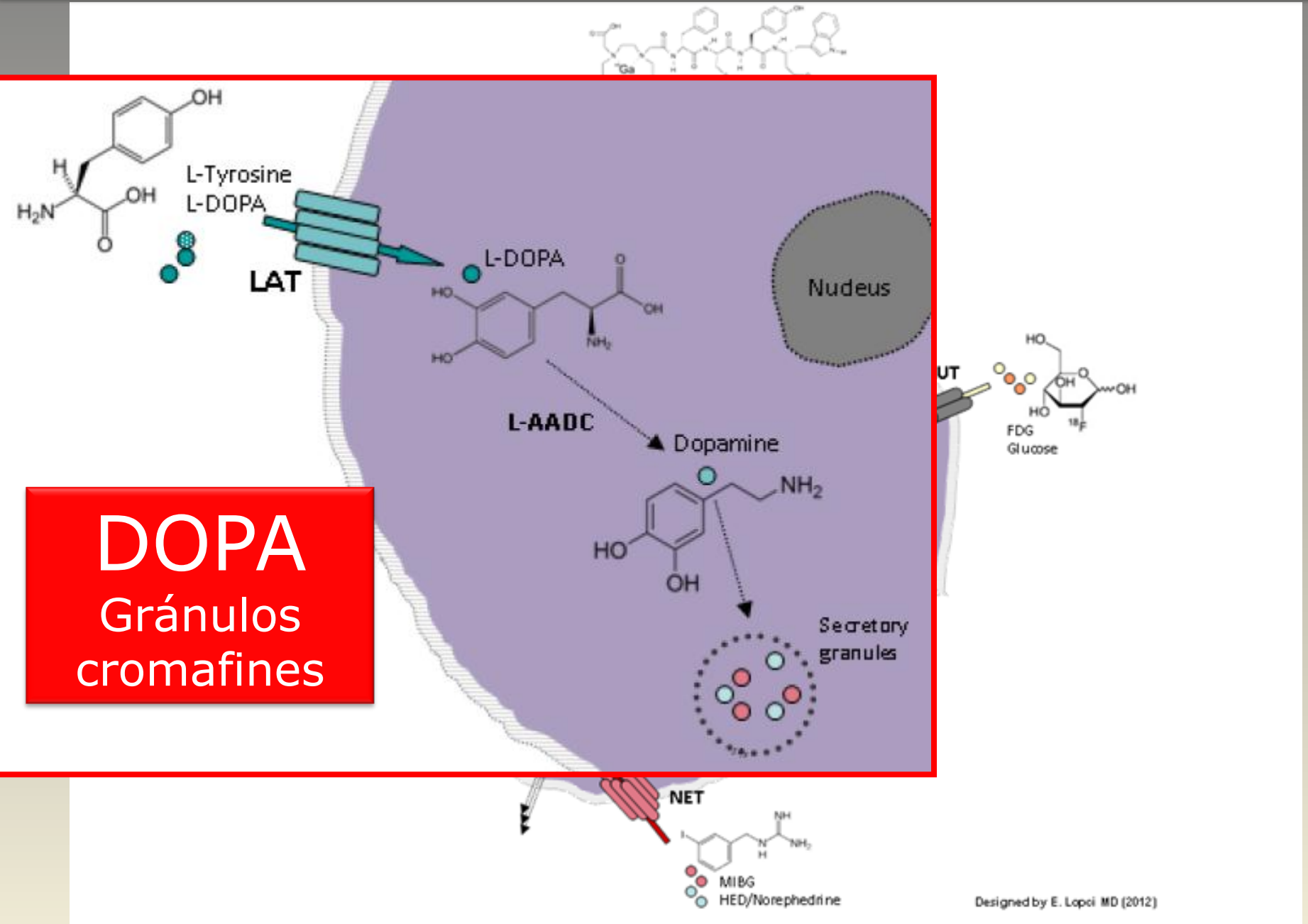
Kang SY, Rahim MK, Kim YI, Cheon GJ, Kang HJ, Shin HY, Kang KW, Chung JK, Kim EE, Lee DS. Clinical Significance of Pretreatment FDG PET/CT in MIBG-Avid Pediatric Neuroblastoma. Nucl Med Mol Imaging. 2017 Jun;51(2):154-160.

Bleeker G, Tytgat GA, Adam JA, Caron HN, Kremer LC, Hooft L, van Dalen EC. 123I-MIBG scintigraphy and 18F-FDG-PET imaging for diagnosing neuroblastoma. Cochrane Database Syst Rev. 2015 Sep 29;(9):CD009263.

Melzer HI, Coppenrath E, Schmid I, Albert MH, von Schweinitz D, Tudball C, Bartenstein P, Pfluger T. ^{123}I-MIBG scintigraphy/SPECT versus ^{18}F-FDG PET in paediatric neuroblastoma. Eur J Nucl Med Mol Imaging. 2011 Sep;38(9):1648-58.

Sharp SE, Shulkin BL, Gelfand MJ, Salisbury S, Furman WL. 123I-MIBG scintigraphy and 18F-FDG PET in neuroblastoma. J Nucl Med. 2009 Aug;50(8):1237-43.

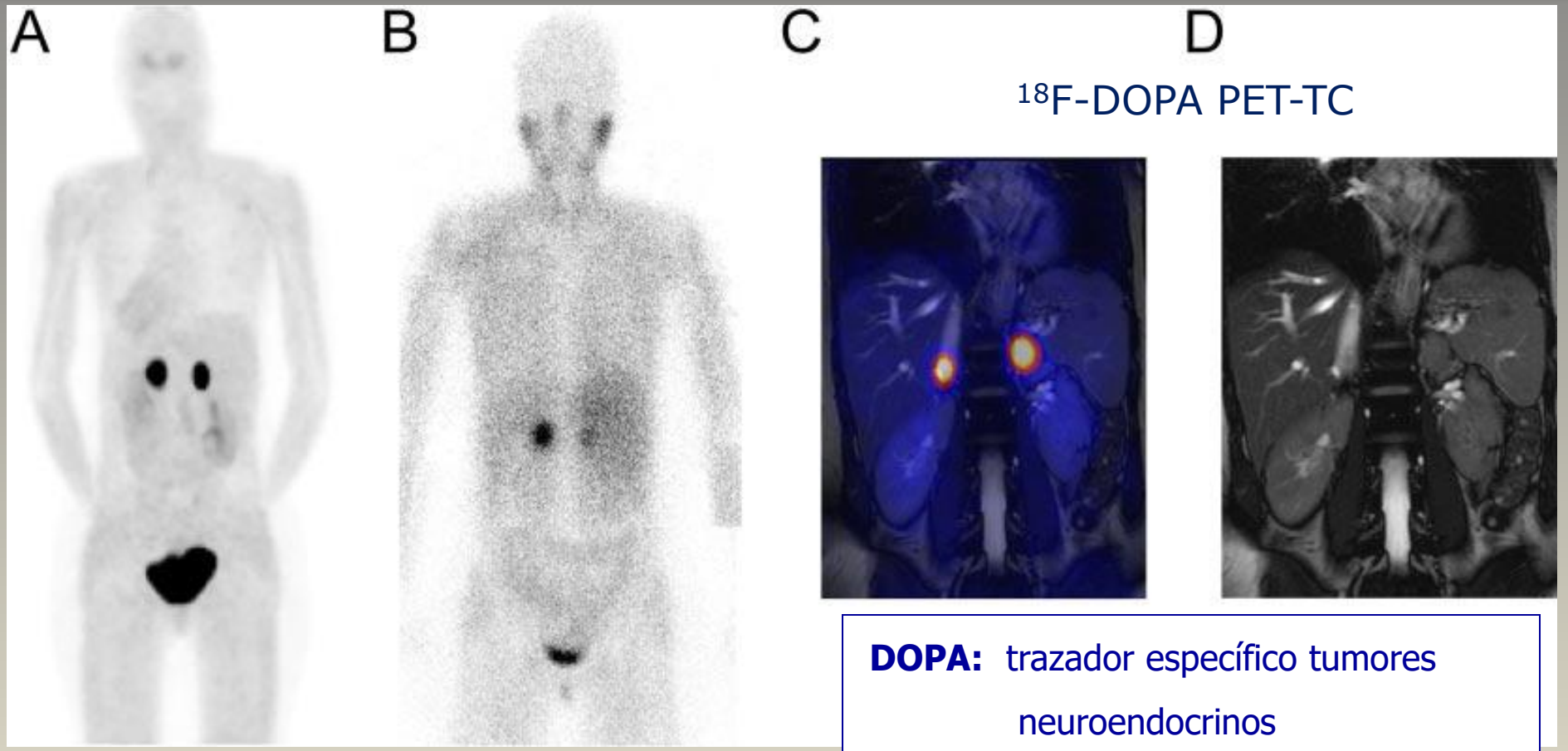
IMAGEN MOLECULAR en el NEUROBLASTOMA



DOPA
Gránulos cromafines

^{18}F-DOPA PET-TC

Feocromocitoma bilateral



^{18}F-DOPA

^{123}I-MIBG

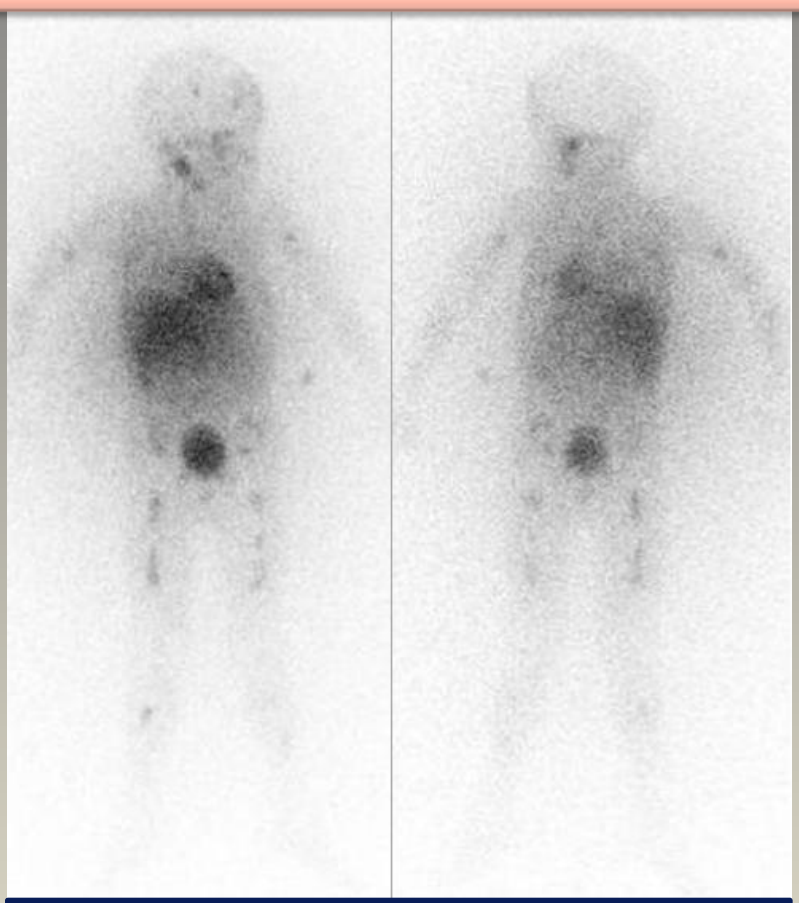
DOPA: trazador específico tumores neuroendocrinos

PET > MIBG: mayor sensibilidad

Fiebrich et al.

J Clin Endocrinol Metab 2009

^{18}F-DOPA PET-TC - Diagnóstico



^{123}I-mIBG Whole Body Scan

^{18}F-DOPA PET/CT

Mayor sensibilidad

- DOPA = imagen PET

Piccardo A, Morana G, Puntoni M, Campora S, Stefania S, Zucchetta P, Ugolini M, Conte M, Cistaro A, Ferrarazzo G, Pescetto M, Lattuada M, Bottoni G, Garaventa A, Giovanella L, Lopci E. Diagnosis, Treatment Response and Prognosis. The role of (18)F-DOPA PET/CT in children affected by Neuroblastoma in comparison with (123)I-mIBG scan. The first prospective study. J Nucl Med. 2019 Sep 20.

Demirsoy U, Demir H, Corapcoğlu F. Bone and lymph node metastases from neuroblastoma detected by (18)F-DOPA-PET/CT and confirmed by posttherapy (131)I-MIBG but negative on diagnostic (123)I-MIBG scan. Clin Nucl Med. 2014 Jul;39(7):673.

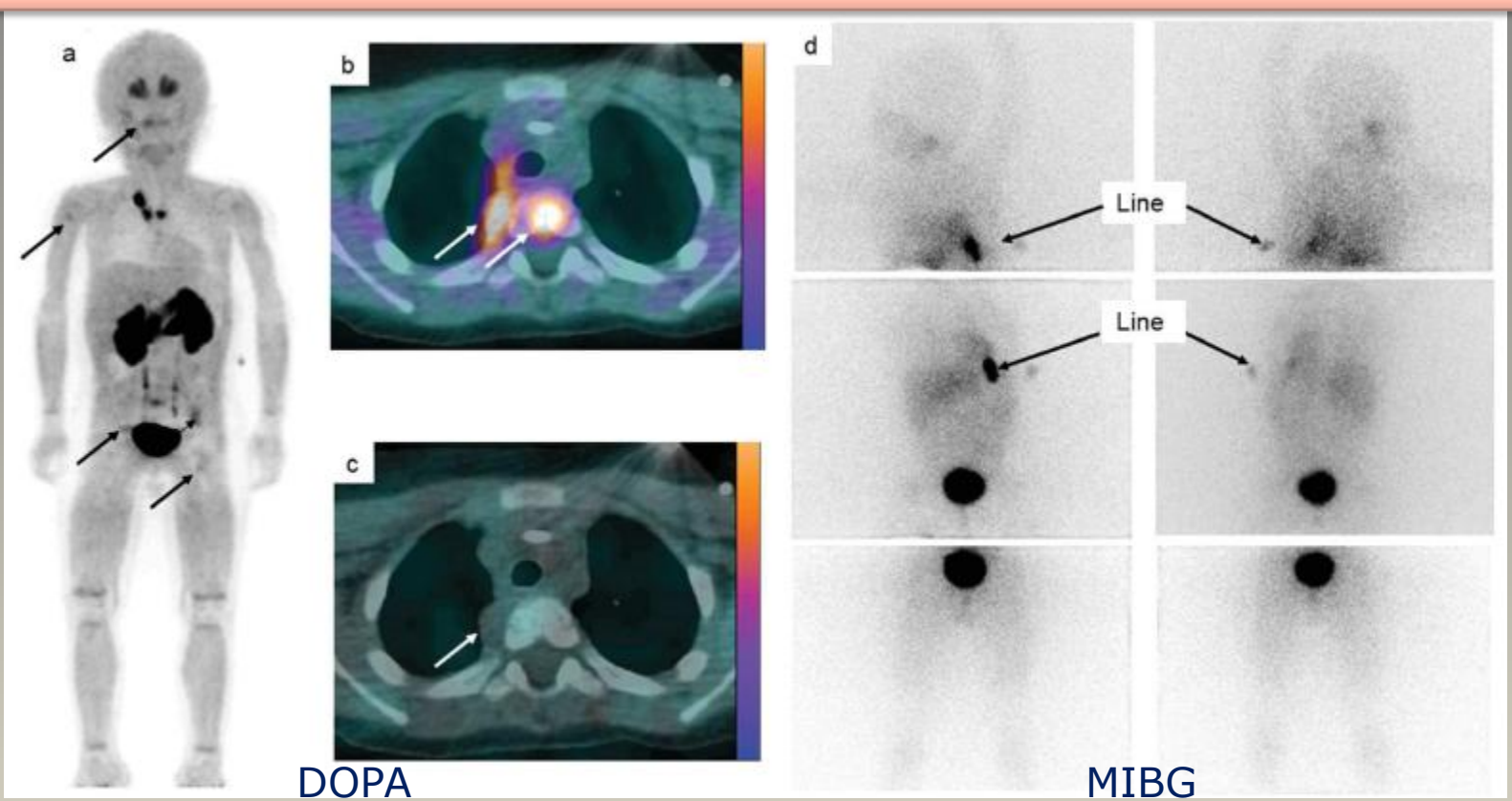
Piccardo A, Puntoni M, Lopci E, Conte M, Foppiani L, Sorrentino S, Morana G, Naseri M, Cistaro A, Villavecchia G, Fanti S, Garaventa A. Prognostic value of ^{18}F-DOPA PET/CT at the time of recurrence in patients affected by neuroblastoma. Eur J Nucl Med Mol Imaging. 2014 Jun;41(6):1046-56.

Piccardo A, Lopci E, Conte M, Cabria M, Cistaro A, Garaventa A, Villavecchia G. Bone and lymph node metastases from neuroblastoma detected by 18F-DOPA PET/CT and confirmed by posttherapy 131I-MIBG but negative on diagnostic 123I-MIBG scan. Clin Nucl Med. 2014 Jan;39(1):e80-3.

Lu MY, Liu YL, Chang HH, Jou ST, Yang YL, Lin KH, Lin DT, Lee YL, Lee H, Wu PY, Luo TY, Shen LH, Huang SF, Liao YF, Hsu WM, Tzen KY; National Taiwan University Neuroblastoma Study Group. Characterization of neuroblastic tumors using 18F-FDOPA PET. J Nucl Med. 2013 Jan;54(1):42-9. d

Piccardo A, Lopci E, Conte M, Garaventa A, Foppiani L, Altrinetti V, Nanni C, Bianchi P, Cistaro A, Sorrentino S, Cabria M, Pession A, Puntoni M, Villavecchia , Fanti S. Comparison of 18F-dopa PET/CT and 123I-MIBG scintigraphy in stage 3 and 4 neuroblastoma: a pilot study. Eur J Nucl Med Mol Imaging. 2012 Jan;39(1):57-71.

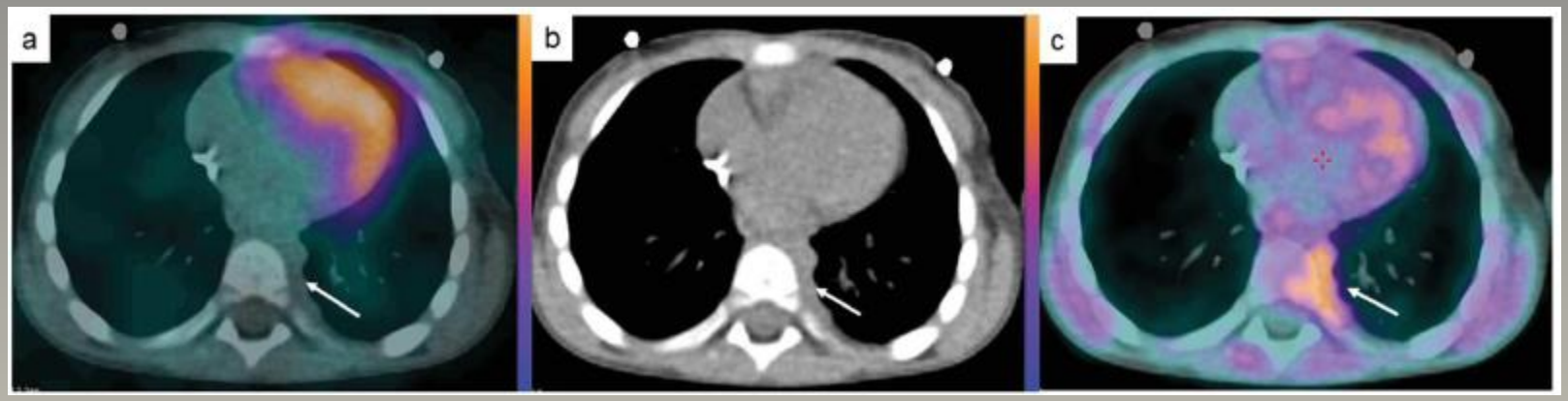
^{18}F-DOPA PET-TC versus ^{123}I-MIBG



3 a, NBL 4 torácico, NMYC amplificado:
- DOPA: tumor primario y mets óseas y medulares
- MIBG con SPECT-TC: no captación

Piccardo A, Morana G, Puntoni M, Campora S, Stefania S, Zucchetta P, Ugolini M, Conte M, Cistaro A, Ferrarazzo G, Pescetto M, Lattuada M, Bottoni G, Garaventa A, Giovanella L, Lopci E. Diagnosis, Treatment Response and Prognosis. The role of (18)F-DOPA PET/CT in children affected by Neuroblastoma in comparison with (123)I-mIBG scan. The first prospective study. J Nucl Med. 2019 Sep 20.

^{18}F-DOPA PET-TC versus ^{123}I-MIBG

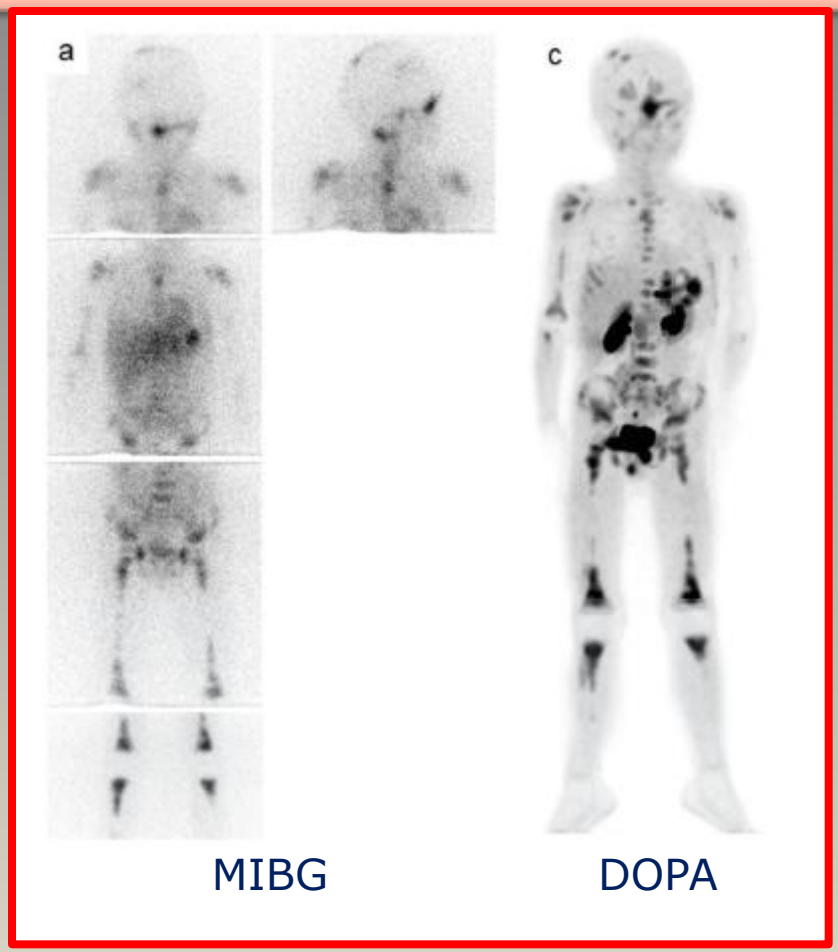


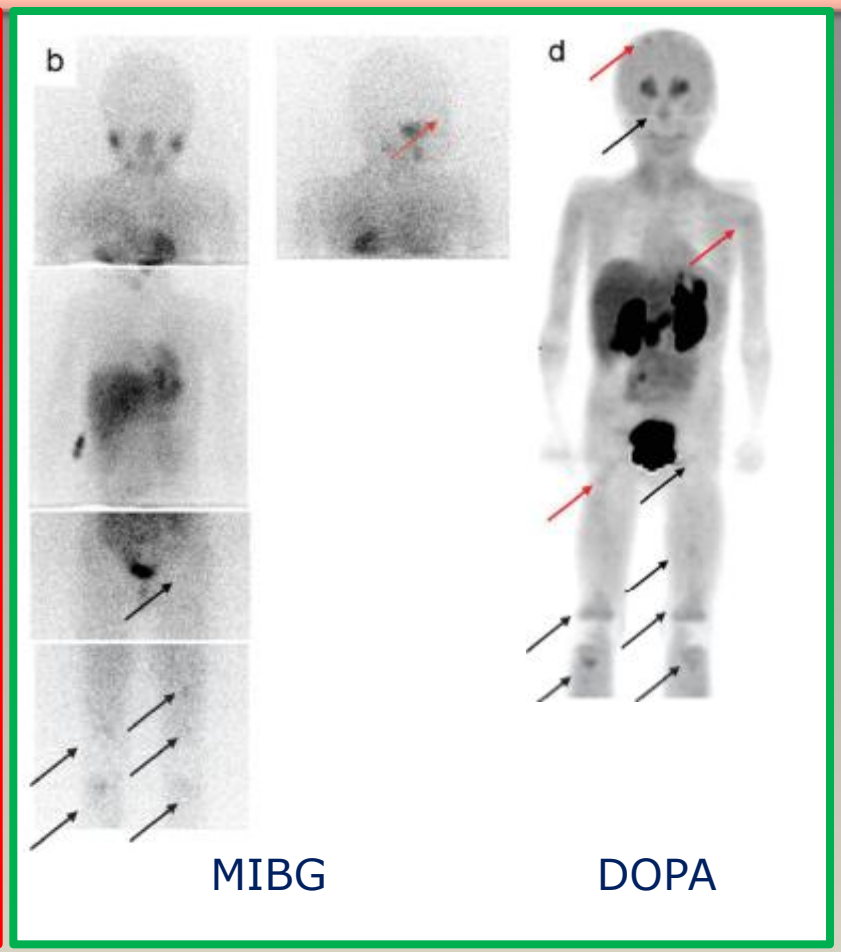
MIBG DOPA

3 a, NBL 3 abdominal, NMYC amplificado:
- TC: Imágenes paravertebrales dudosas
- DOPA: nódulos paravertebrales y vértebra +
- MIBG con SPECT-TC: no captación

Piccardo A, Morana G, Puntoni M, Campora S, Stefania S, Zucchetta P, Ugolini M, Conte M, Cistaro A, Ferrarazzo G, Pescetto M, Lattuada M, Bottoni G, Garaventa A, Giovanella L, Lopci E. Diagnosis, Treatment Response and Prognosis. The role of (18)F-DOPA PET/CT in children affected by Neuroblastoma in comparison with (123)I-mIBG scan. The first prospective study. J Nucl Med. 2019 Sep 20.

^{18}F-DOPA PET-TC versus ^{123}I-MIBG





3 a, NBL 4 abdominal, NMYC no amplif:

- Diagnóstico: DOPA = MIBG
- Post inducción: DOPA > MIBG
  - Cráneo
  - Huesos largos

P, Ugolini M, Conte M, Cistaro A, L, Lopci E. Diagnosis, Treatment en affected by Neuroblastoma in study. J Nucl Med. 2019 Sep 20.

^{18}F-DOPA PET-TC versus ^{123}I-MIBG

Dimension of soft tissue recurrence/metastases	^{123}I-MIBG scan		^{18}F-Dopa PET/CT	
	Positive	Negative	Positive	Negative
<1.5 cm	0	19	17	2
>1.5 cm and <3 cm	12	11	19	4
>3 cm	2	1	2	1
Total	14	31	38	7

Piccardo A, Lopci E, Conte M, Garaventa A, Foppiani L, Altrinetti V, Nanni C, Bianchi P, Cistaro A, Sorrentino S, Cabria M, Pession A, Puntoni M, Villavecchia , Fanti S. Comparison of 18F-dopa PET/CT and 123I-MIBG scintigraphy in stage 3 and 4 neuroblastoma: a pilot study. Eur J Nucl Med Mol Imaging. 2012 Jan;39(1):57-71.

^{18}F-DOPA PET-TC versus ^{123}I-MIBG

Table 2. Patients based analysis. Detection rates (%) were calculated for each single diagnostic modality in each site of disease*.

	^{123}I-mIBG SPECT/CT	^{18}F-DOPA PET/CT	p**
Before induction chemotherapy			
Primary Tumors	15 (83%)	17 (94%)	0.5
Soft Tissue metastases	6 (50%)	11 (92%)	0.06
Bone/Bone marrow metastases	12 (92%)	13 (100%)	1.0
After induction chemotherapy			
Primary Tumor	13 (72%)	15 (83%)	0.6
Soft Tissue metastases	4 (33%)	9 (75%)	0.06
Bone/Bone marrow metastases	5 (38%)	7 (54%)	1.0

N = 18 pacientes

Piccardo A, Morana G, Puntoni M, Campora S, Stefania S, Zucchetta P, Ugolini M, Conte M, Cistaro A, Ferrarazzo G, Pescetto M, Lattuada M, Bottoni G, Garaventa A, Giovanella L, Lopci E. Diagnosis, Treatment Response and Prognosis. The role of (18)F-DOPA PET/CT in children affected by Neuroblastoma in comparison with (123)I-mIBG scan. The first prospective study. J Nucl Med. 2019 Sep 20.

^{18}F-DOPA PET-TC versus ^{123}I-MIBG

Table 3. Lesion based analysis. Detection rates (%) were calculated for each single diagnostic modality in each site of disease*.

	^{123}I-mIBG SPECT/CT	^{18}F-DOPA PET/CT	p**
Before induction chemotherapy			
Soft Tissue metastases	20 (41%)	42 (86%)	<0.001
Bone/Bone marrow metastases	494 (93%)	522 (99%)	<0.001
After induction chemotherapy			
Soft Tissue metastases	11 (28%)	30 (77%)	<0.001
Bone/Bone marrow metastases	54 (69%)	67 (86%)	0.001

N = 18 pacientes

Piccardo A, Morana G, Puntoni M, Campora S, Stefania S, Zucchetta P, Ugolini M, Conte M, Cistaro A, Ferrarazzo G, Pescetto M, Lattuada M, Bottoni G, Garaventa A, Giovanella L, Lopci E. Diagnosis, Treatment Response and Prognosis. The role of (18)F-DOPA PET/CT in children affected by Neuroblastoma in comparison with (123)I-mIBG scan. The first prospective study. J Nucl Med. 2019 Sep 20.

^{18}F-DOPA PET-TC versus ^{123}I-MIBG

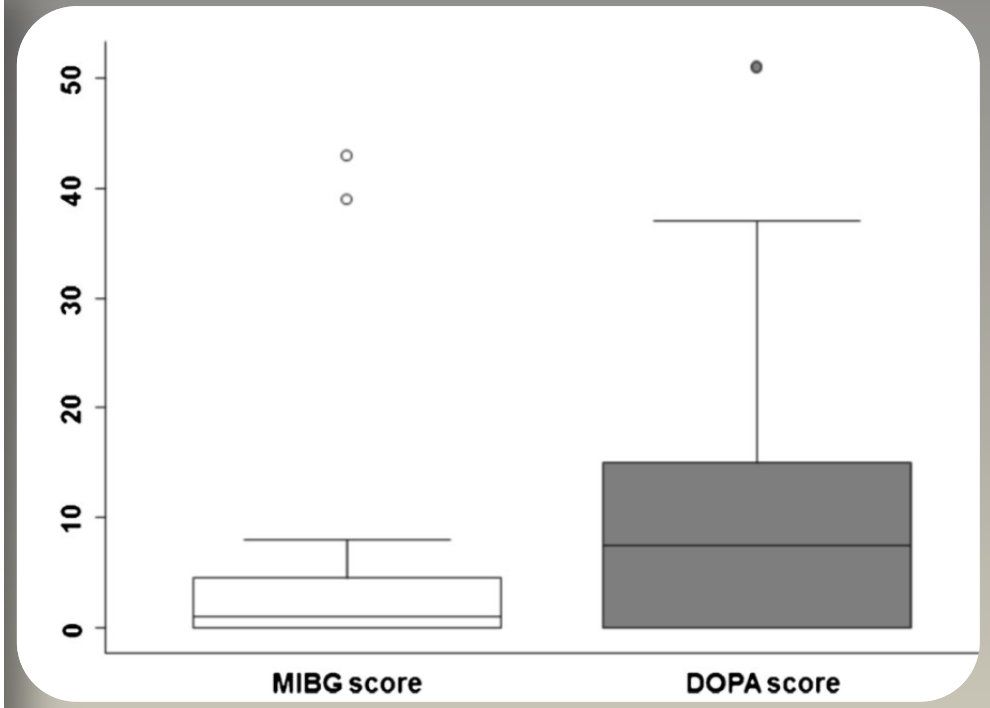
SENSITIVITY AT DIAGNOSIS	PBA		LBA	
	PATIENT		LESIONS	
	MIBG	DOPA	MIBG	DOPA
TUMOR	83%	94%		
SOFT TISSUE	50%	92%	41%	86%
BONE/BONE MARROW METS	92%	100%	93%	99%

SENSITIVITY AFTER THERAPY	PBA		LBA	
	PATIENT		LESIONS	
	MIBG	DOPA	MIBG	DOPA
TUMOR	72%	83%		
SOFT TISSUE	33%	75%	28%	77%
BONE/BONE MARROW METS	38%	54%	69%	86%

N = 18 pacientes

Piccardo A, Morana G, Puntoni M, Campora S, Stefania S, Zucchetta P, Ugolini M, Conte M, Cistaro A, Ferrarazzo G, Pescetto M, Lattuada M, Bottoni G, Garaventa A, Giovanella L, Lopci E. Diagnosis, Treatment Response and Prognosis. The role of (18)F-DOPA PET/CT in children affected by Neuroblastoma in comparison with (123)I-mIBG scan. The first prospective study. J Nucl Med. 2019 Sep 20.

DOPA, MIBG and SIOPEN SCORE



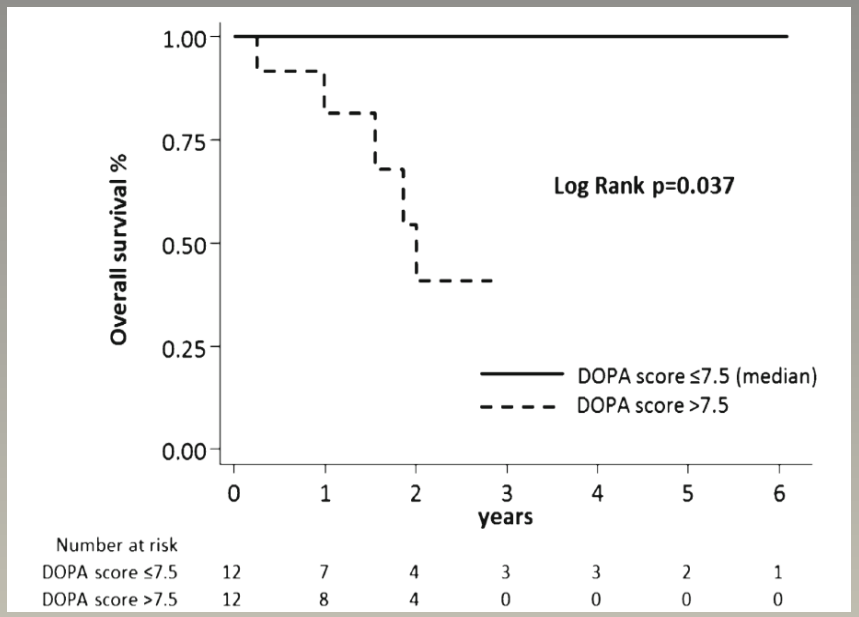
DOPA detecta más lesiones

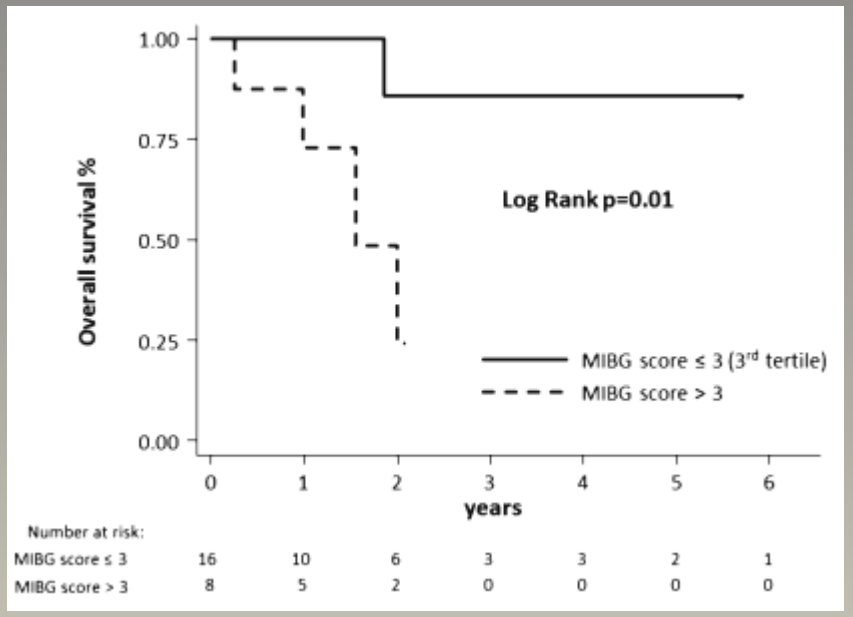
SIOPEN score más alto

Mejor estadiaje

Piccardo A, Puntoni M, Lopci E, Conte M, Foppiani L, Sorrentino S, Morana G, Naseri M, Cistaro A, Villavecchia G, Fanti S, Garaventa A.
Prognostic value of ^{18}F-DOPA PET/CT at the time of recurrence in patients affected by neuroblastoma.
Eur J Nucl Med Mol Imaging. 2014 Jun;41(6):1046-56. .

DOPA, MIBG and SIOPEN SCORE





DOPA score cut-off < 7,5

Score SIOPEN < 3

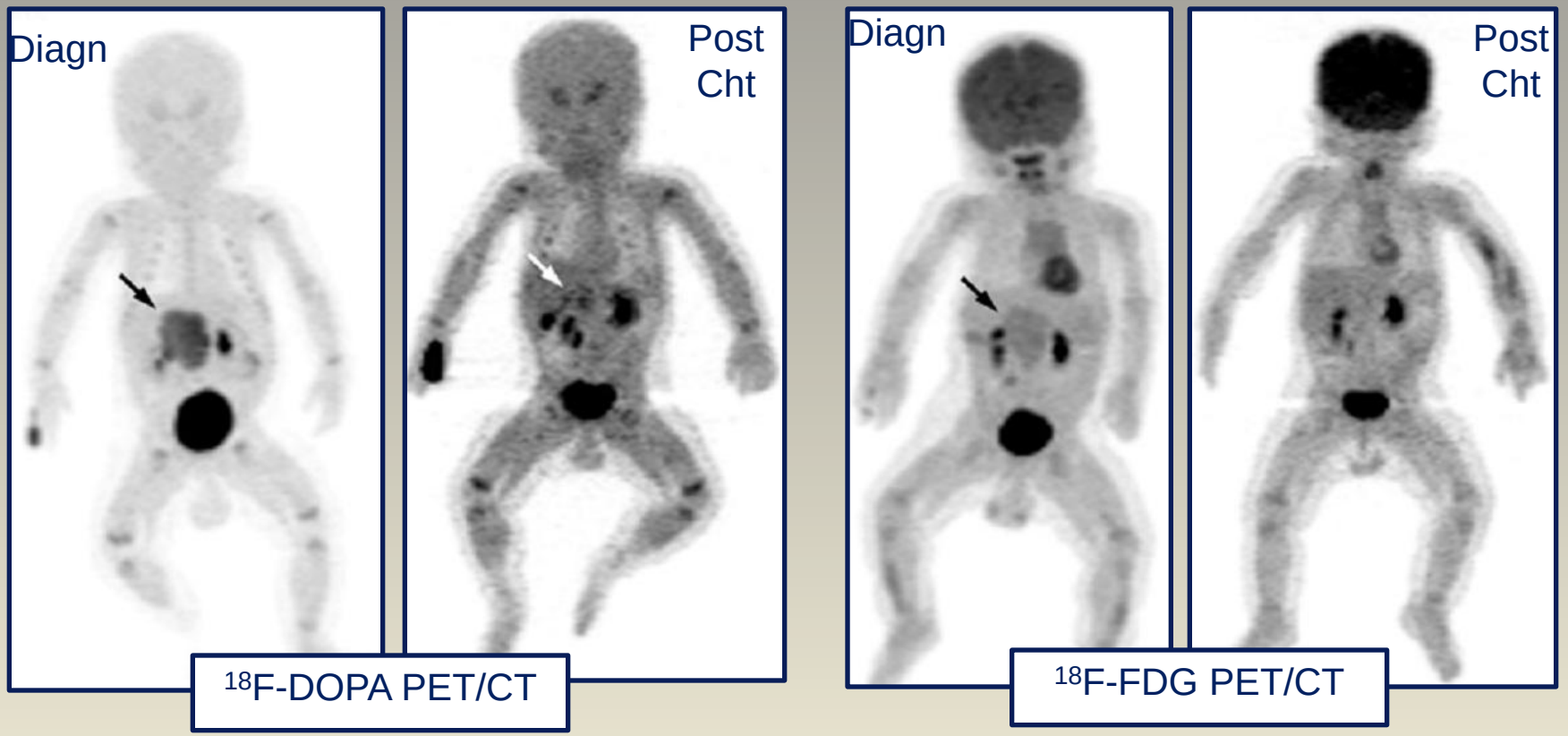
DOPA score: SIOPEN score x SUVmean

Ladenstein R, Lambert B, Pötschger U, Castellani MR, Lewington V, Bar-Sever Z, Oudoux A, Śliwińska A, Taborska K, Biassoni L, Yanik GA, Naranjo A, Parisi MT, Shulkin BL, Nadel H, Gelfand MJ, Matthay KK, Park JR, Kreissman SG, Valteau-Couanet D, Boubaker A. Validation of the mIBG skeletal SIOPEN scoring method in two independent high risk neuroblastoma populations: the SIOPEN/HR-NBL1 and COG-A3973 trials. Eur J Nucl Med Mol Imaging. 2018 Feb;45(2):292-305.

Piccardo A, Puntoni M, Lopci E, Conte M, Foppiani L, Sorrentino S, Morana G, Naseri M, Cistaro A, Villavecchia G, Fanti S, Garaventa A. Prognostic value of ^{18}F-DOPA PET/CT at the time of recurrence in patients affected by neuroblastoma. Eur J Nucl Med Mol Imaging. 2014 Jun;41(6):1046-56. .

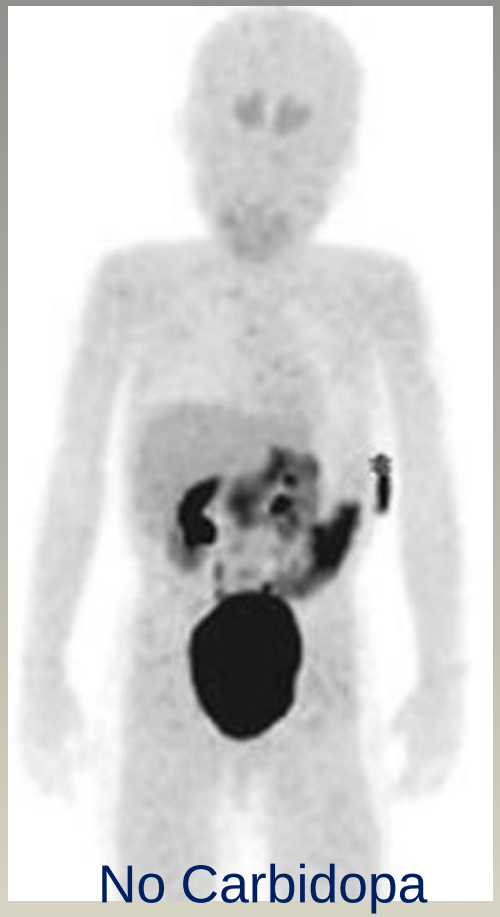
^{18}F-DOPA PET-TC versus ^{18}F-FDG

SENSITIVITY	LBA	
	LESIONS	
	FDG	DOPA
TUMOR	97%	87%



Lu MY, Liu YL, Chang HH, Jou ST, Yang YL, Lin KH, Lin DT, Lee YL, Lee H, Wu PY, Luo TY, Shen LH, Huang SF, Liao YF, Hsu WM, Tzen KY; National Taiwan University Neuroblastoma Study Group. Characterization of neuroblastic tumors using 18F-FDOPA PET. J Nucl Med. 2013 Jan;54(1):42-9. d

^{18}F-DOPA PET-TC - carbidopa



No Carbidopa

Carbidopa

Aumento captación:

- Ganglios basales
- Parenquima hepático

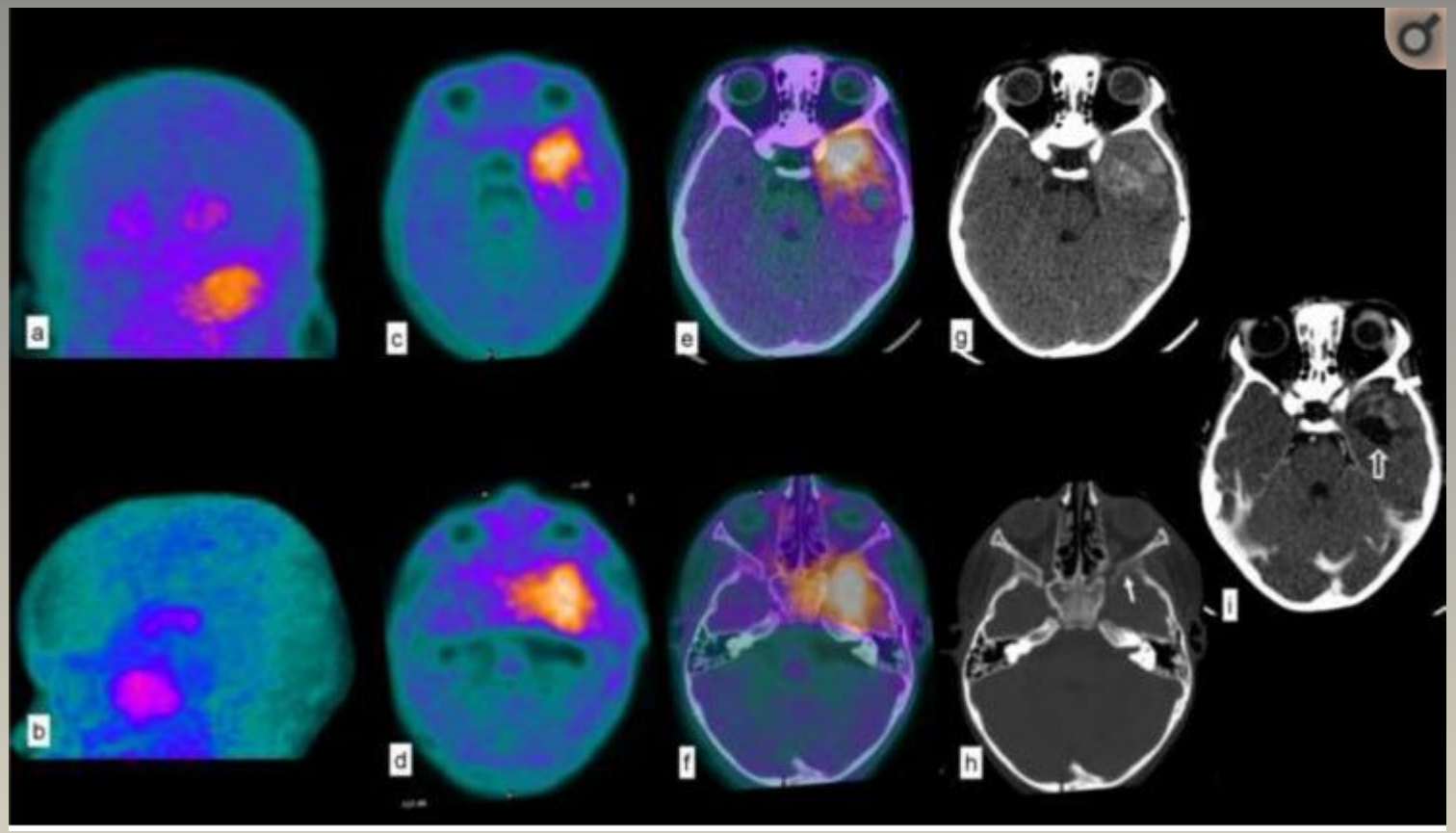
Disminución captación:

- Cortex renal
- Pancreas

2 mg/kg of carbidopa

Lopci E, D'Ambrosio D, Nanni C, Chiti A, Pession A, Marengo M, Fanti S. Feasibility of carbidopa premedication in pediatric patients: a pilot study. Cancer Biother Radiopharm. 2012 Dec;27(10):729-33.

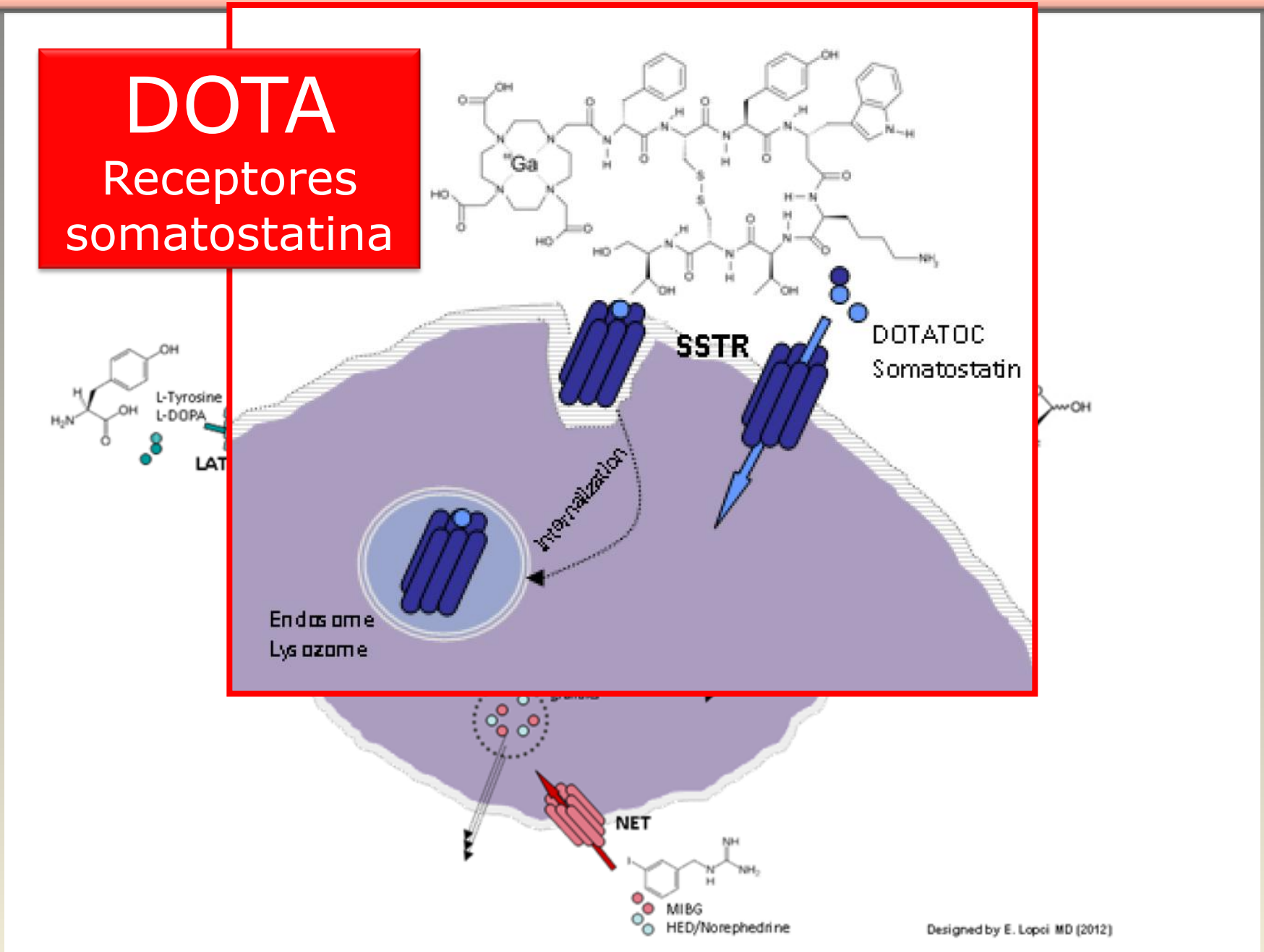
^{18}F-DOPA PET-TC - metastasis cerebrales



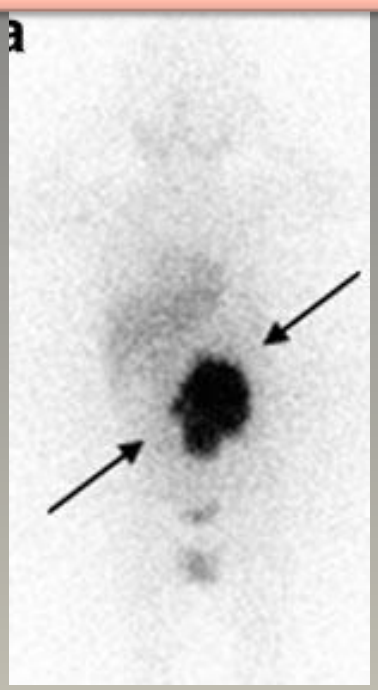
Yu J, Zheng J, Xu W, Weng J, Gao L, Tao L, Liang F, Zhang J. Accuracy of (18)F-FDOPA Positron Emission Tomography and (18)F-FET Positron Emission Tomography for Differentiating Radiation Necrosis from Brain Tumor Recurrence. World Neurosurg. 2018 Jun;114:e1211-e1224. d

Piccardo A, Morana G, Massollo M, Pescetto M, Conte M, Garaventa A. Brain Metastasis from Neuroblastoma Depicted by (18)F-DOPA PET/CT. Nucl Med Mol Imaging. 2015 Sep;49(3):241-2.

IMAGEN MOLECULAR en el NEUROBLASTOMA

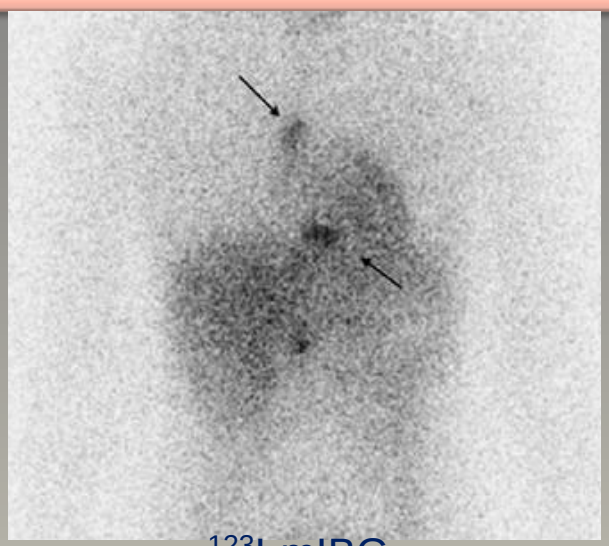


^{68}Ga-DOTA versus MIBG



^{123}I-mIBG

^{68}Ga-DOTATOC



^{123}I-mIBG

5 pacientes

^{68}Ga-DOTATOC

Table 2 Comparison of imaging modalities by lesion

Lesion	Modality	No. of positive lesions	No. positive on CT/MRI	Sensitivity (%)
Metastatic phaeochromocytoma	^{68}Ga-DOTA-TOC	100	109	91.7
	^{123}I-MIBG	69	109	63.3
Neuroblastoma	^{68}Ga-DOTA-TOC	104	107	97.2
	^{123}I-MIBG	97	107	90.7
All	^{68}Ga-DOTA-TOC	204	216	94.4
	^{123}I-MIBG	166	216	76.9

Kroiss A, Putzer D, Uprimny C, Decristoforo C, Gabriel M, Santner W, Kranewitter C, Warwitz B, Waitz D, Kendler D, Virgolini IJ. Functional imaging in phaeochromocytoma and neuroblastoma with 68Ga-DOTA-Tyr 3 octreotide positron emission tomography and 123I-metaiodobenzylguanidine. Eur J Nucl Med Mol Imaging. 2011 May;38(5):865-73.

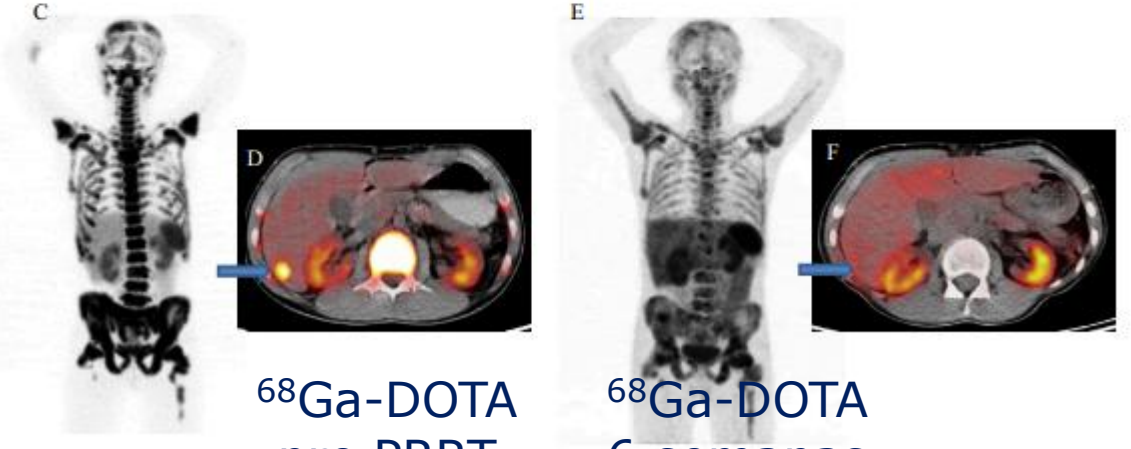
^{68}Ga-DOTA – THERANOSTICS

diagnóstico y tratamiento

^{123}I-MIBG

18 AÑOS

NBL 4 a los 7 años
Varias recurrencias MIBG-



^{68}Ga-DOTA
pre PRRT

^{68}Ga-DOTA
6 semanas
post PRRT ^{177}Lu-DOTA

- Mets oseas/medulares
- Mets hepáticas

- RP ósea y medular
- RC mets hepática

PRRT
Peptide
Receptor
Radionuclide
Therapy

Alexander N, Vali R, Ahmadzadehfar H, Shammas A, Baruchel S. Review: The Role of Radiolabeled DOTA-Conjugated Peptides for Imaging and Treatment of Childhood Neuroblastoma. Curr Radiopharm. 2018;11(1):14-21.

^{68}Ga-DOTA – THERANOSTICS

diagnóstico y tratamiento

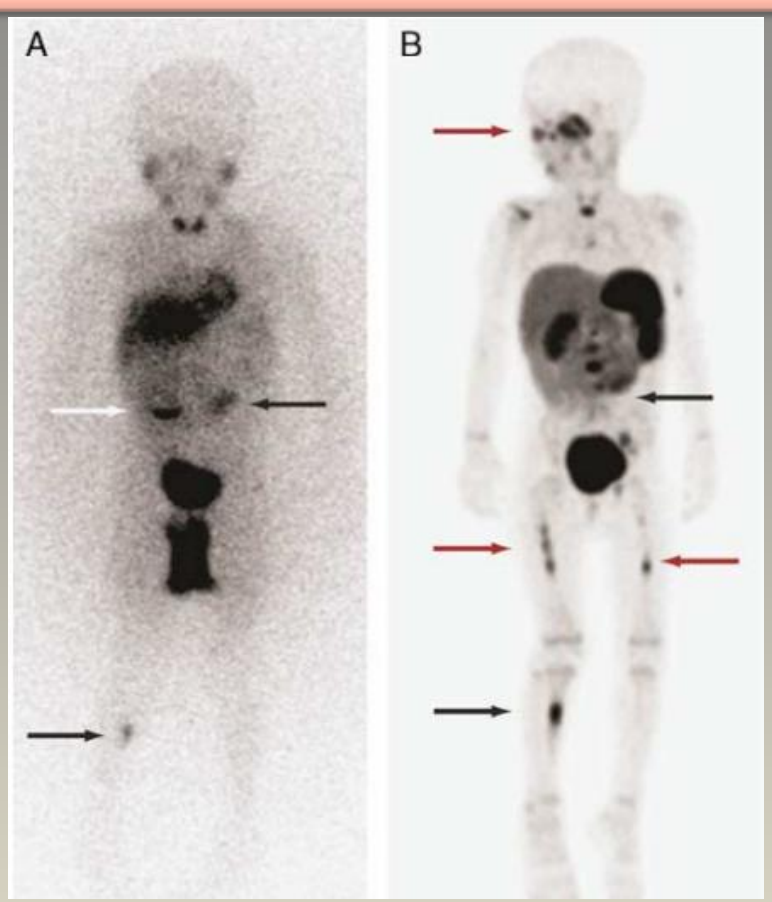
TABLE 1. Patient Characteristics

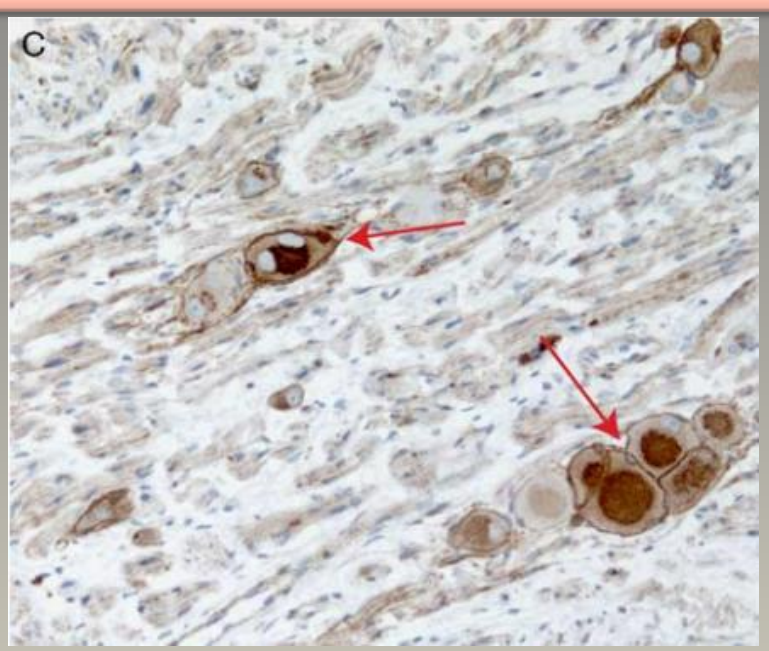
Patient	Age (y)	Sex	Purpose for Ga-68 DOTATATE PET/CT Scan	Previous ^{131}I-MIBG Treatment	No. Cycles ^{131}I-MIBG Treatment
1	3	Female	Restaging	No	0
2	6	Male	Restaging	Yes	3
3	2	Female	Restaging	Yes	2
4	3	Male	Restaging	Yes	2
5	5	Male	Restaging	Yes	3
6	5	Female	Restaging	Yes	3
7	6	Female	Restaging	Yes	2
8	7	Female	Restaging	Yes	5 (initial 2 cycles, followed by 3 cycles 22 mo later due to recurrence)

Kong G, Hofman MS, Murray WK, Wilson S, Wood P, Downie P, Super L, Hogg A, Eu P, Hicks RJ. Initial Experience With Gallium-68 DOTA-Octreotate PET/CT and Peptide Receptor Radionuclide Therapy for Pediatric Patients With Refractory Metastatic Neuroblastoma. J Pediatr Hematol Oncol. 2016 Mar;38(2):87-96.

^{68}Ga-DOTA – THERANOSTICS

diagnóstico y tratamiento





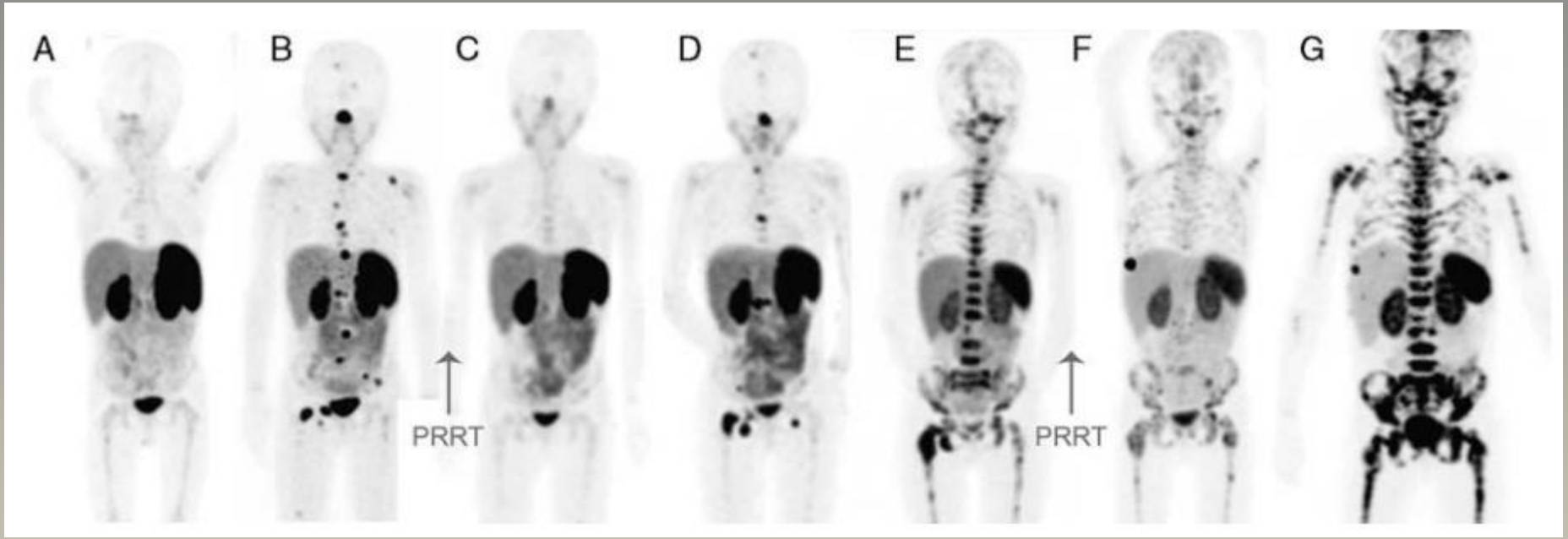
- Lesión abdominal y femoral MIBG+ y DOTA+
- Inmunohistoquimica + para receptores somatostatina subtipo 2

Paciente apto para PRRT

Kong G, Hofman MS, Murray WK, Wilson S, Wood P, Downie P, Super L, Hogg A, Eu P, Hicks RJ. Initial Experience With Gallium-68 DOTA-Octreotate PET/CT and Peptide Receptor Radionuclide Therapy for Pediatric Patients With Refractory Metastatic Neuroblastoma. J Pediatr Hematol Oncol. 2016 Mar;38(2):87-96.

^{68}Ga-DOTA – THERANOSTICS

diagnóstico y tratamiento



Our preliminary results of combining 177Lu-DOTATATE with temozolamide and etoposide may warrant more aggressive treatment protocols, including use in combination with other types of radiosensitizing chemotherapy in high-risk patients with residual or relapsed disease, particularly with diffuse marrow infiltration, perhaps including stem-cell rescue.

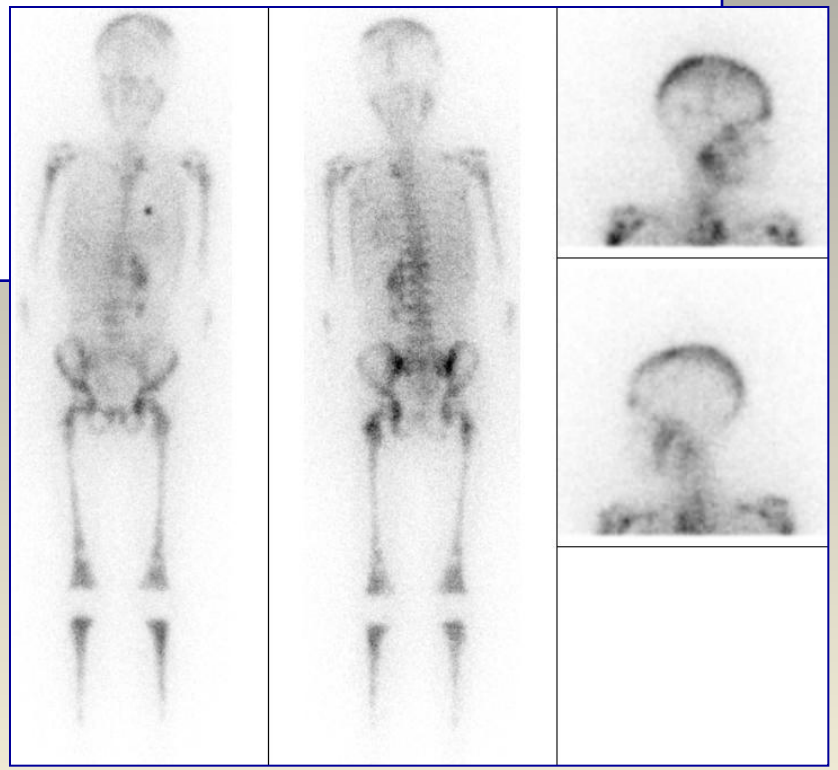
Kong G, Hofman MS, Murray WK, Wilson S, Wood P, Downie P, Super L, Hogg A, Eu P, Hicks RJ. Initial Experience With Gallium-68 DOTA-Octreotate PET/CT and Peptide Receptor Radionuclide Therapy for Pediatric Patients With Refractory Metastatic Neuroblastoma. J Pediatr Hematol Oncol. 2016 Mar;38(2):87-96.

RESUMEN

^{123}I-MIBG vs nuevas técnicas y radiofármacos

- **MIBG:** sigue siendo el método validado para imagen planar metabólica del neuroblastoma
- Varias publicaciones con nuevos índices basados en imagen tomográfica SPECT y PET y con nuevos radiofármacos
- **SIOPEN** está preparando un nuevo score con mayor SENSIBILIDAD que el actual, y que tendrá en cuenta
  - SPECT
  - SPECT-TC
  - Nuevos trazadores PET:

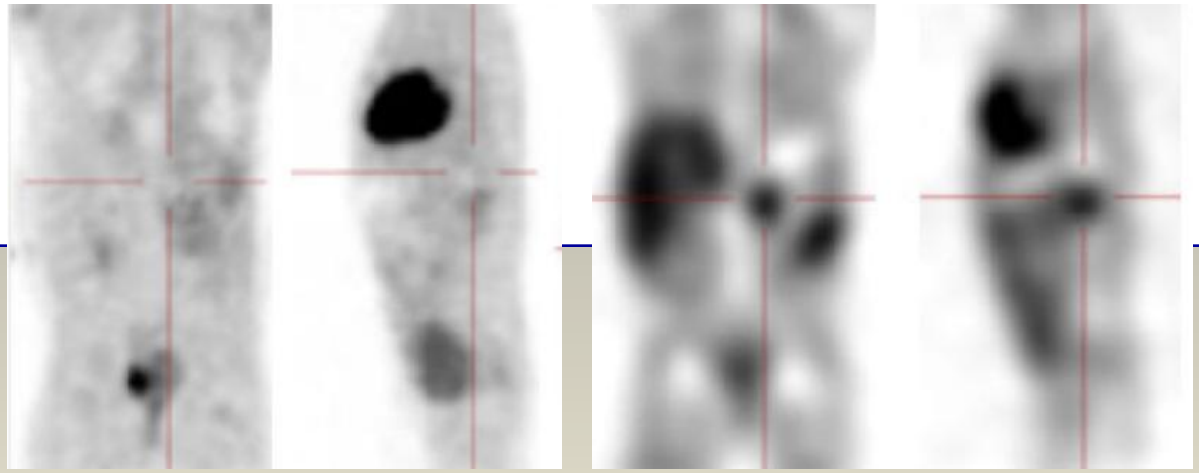
    DOPA, FDG



RESUMEN

^{18}F-FDG PET-TC vs ^{123}I-MIBG

- **^{123}I-MIBG** y **^{18}FDG-PET** presentan **diferencias significativas** en sus patrones de captación
  - Información metabólica de diferentes líneas celulares
  - Correlación metabólico-patológica
  - FN FDG o diferenciación? Biopsia



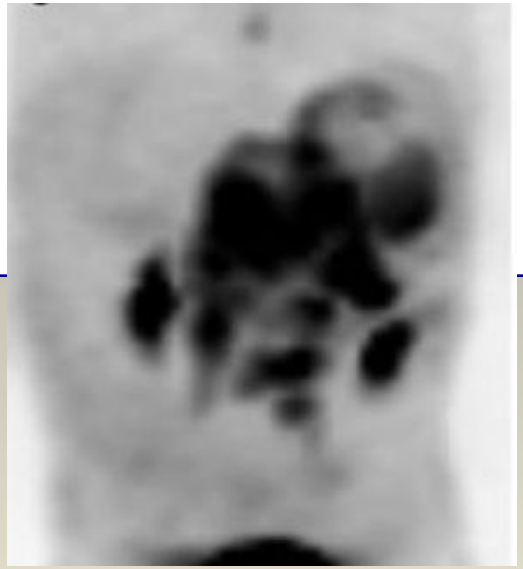
^{18}FDG-PET ^{123}I-MIBG

FN de PET-FDG ?

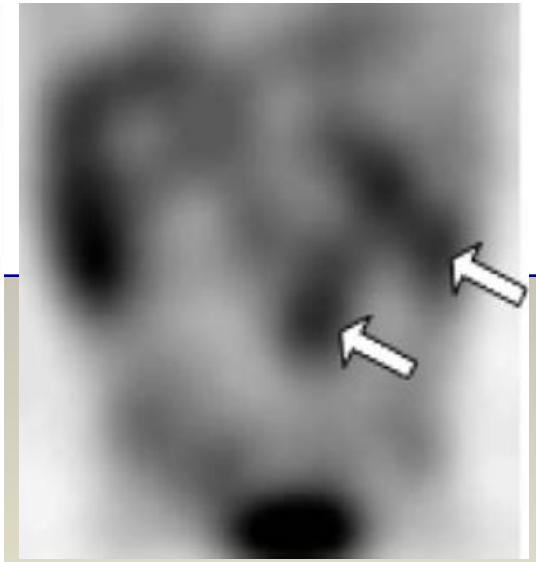
RESUMEN

^{18}F-FDG PET-TC vs ^{123}I-MIBG

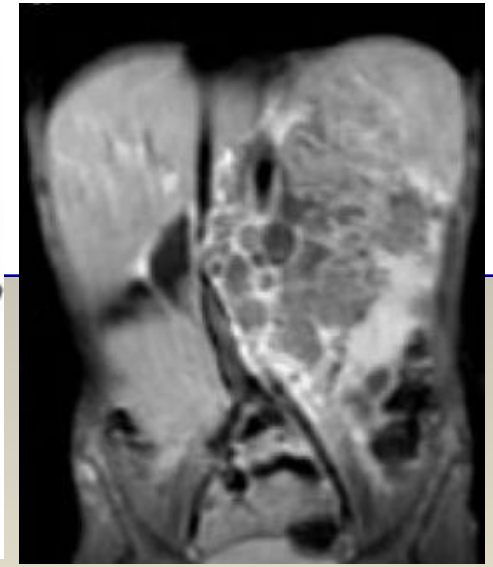
- **^{123}I-MIBG** y **^{18}FDG-PET** presentan **diferencias significativas** en sus patrones de captación
  - Información metabólica de diferentes líneas celulares
  - Correlación metabólico-patológica
  - FN FDG o diferenciación?
  - FN MIBG: mayor agresividad? Cambio líneas celulares, histopatología



^{18}FDG-PET



^{123}I-MIBG



RM

FN de MIBG

RESUMEN

^{18}F-FDG PET-TC vs ^{123}I-MIBG

- ^{18}FDG-PET **se recomienda** para detectar neuroblastoma sin o con bajo grado de captación de ^{123}I-MIBG

^{18}FDG-PET ^{123}I-MIBG

RESUMEN: ^{18}F-FDG PET-TC vs ^{123}I-MIBG

- **MRI es indispensable** (canal espinal, medula ósea) **en el diagnóstico primario** => PET/CT no representa actualmente una alternativa

- **seguimiento:**
  * la especificidad de MRI/CT no es aceptable
  * MIBG y FDG-PET tienen resultados comparables

SEGUIMIENTO	MIBG	FDG-PET	MIBG y FDG	CT o RM
SENSIBILIDAD	48	64	90	100
ESPECIFICIDAD	82	91	91	18

RESUMEN

Nuevas estrategias diagnósticas

- ^{18}F-DOPA y nuevos RF PET sustituirán ^{123}I-MIBG con mayor sensibilidad y resolución de imagen
- ^{18}F-DOPA y nuevos RF PET estadían mejor que MIBG
- SIOPEN oct 2019: estudio multicéntrico para análisis comparativo MIBG-DOPA al diagnóstico y fin inducción

- Cuando existan discrepancias entre RM/TC y MIBG o DOPA,

  => FDG-PET
- NBL MIBG o DOPA negativas o negativizadas: PET-FDG