PET/CT ^{18}F-FDG EN CANCER DE TIROIDES

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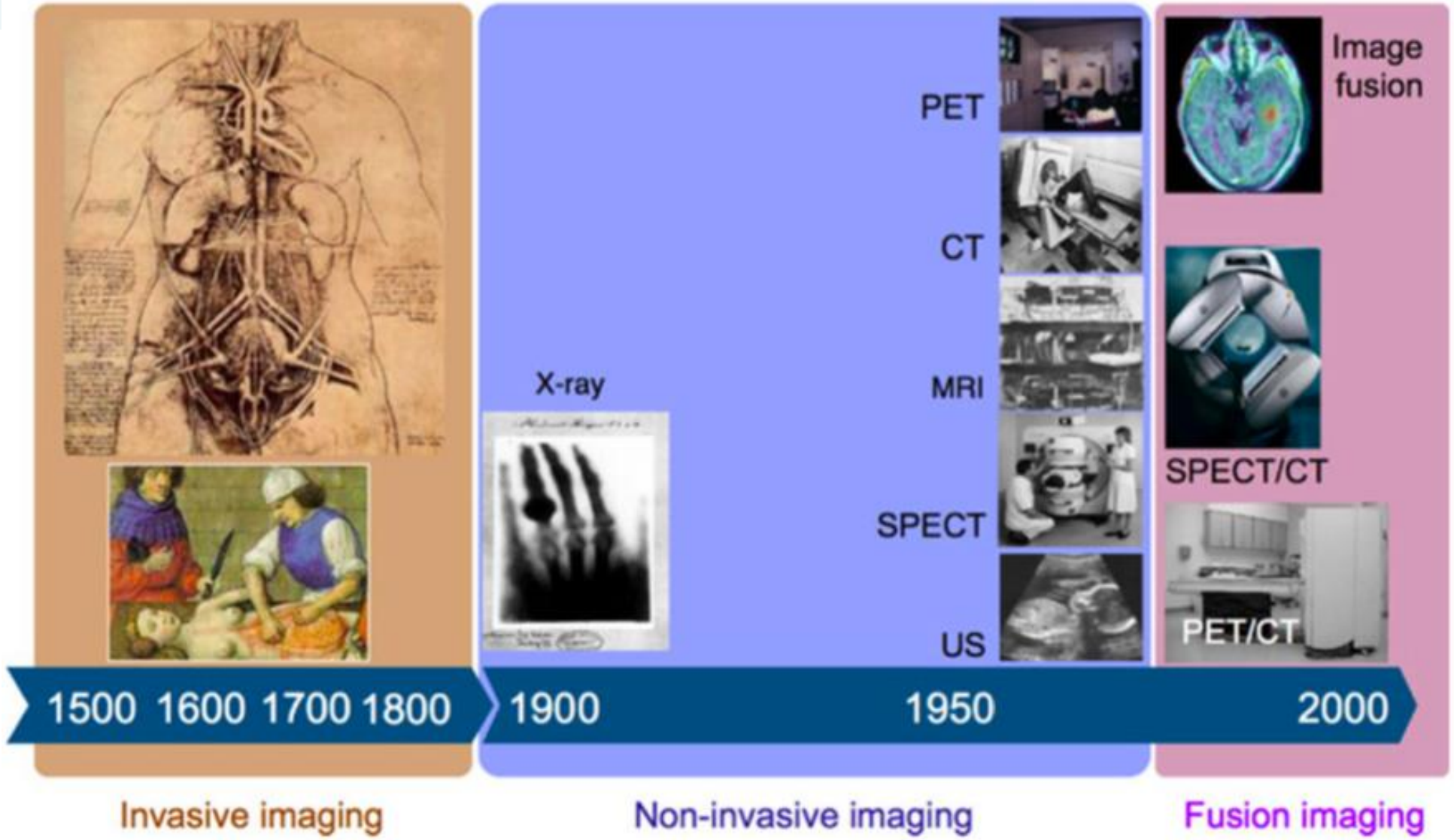
PET
CT
MRI
SPECT
US
X-ray
Image fusion
SPECT/CT
PET/CT
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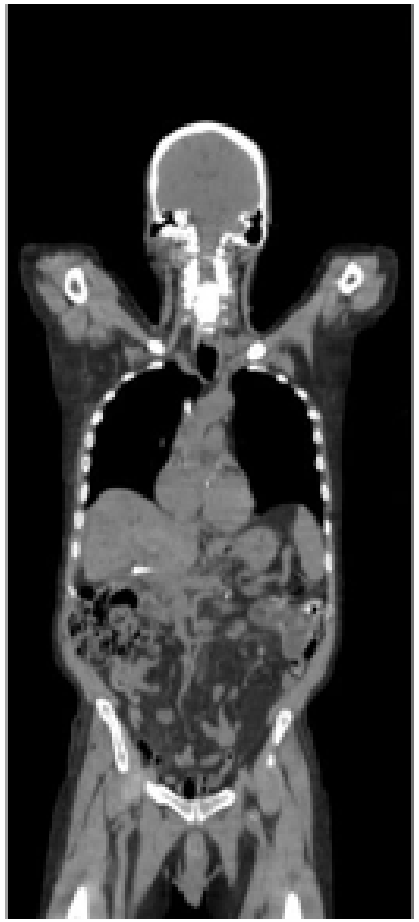
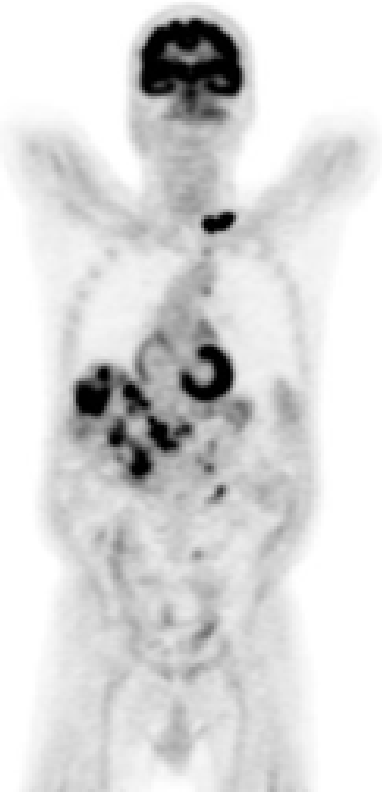
Invasive imaging
Non-invasive imaging
Fusion imaging

TECNICAS HIBRIDAS EN MEDICINA NUCLEAR

TC/RM





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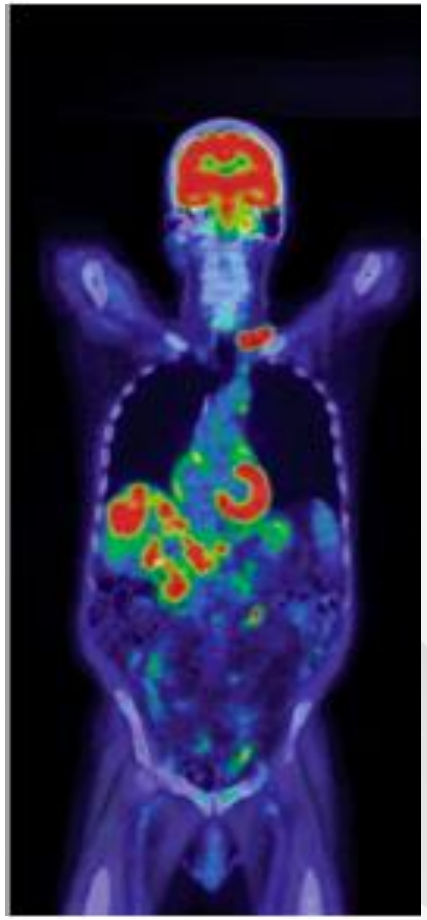
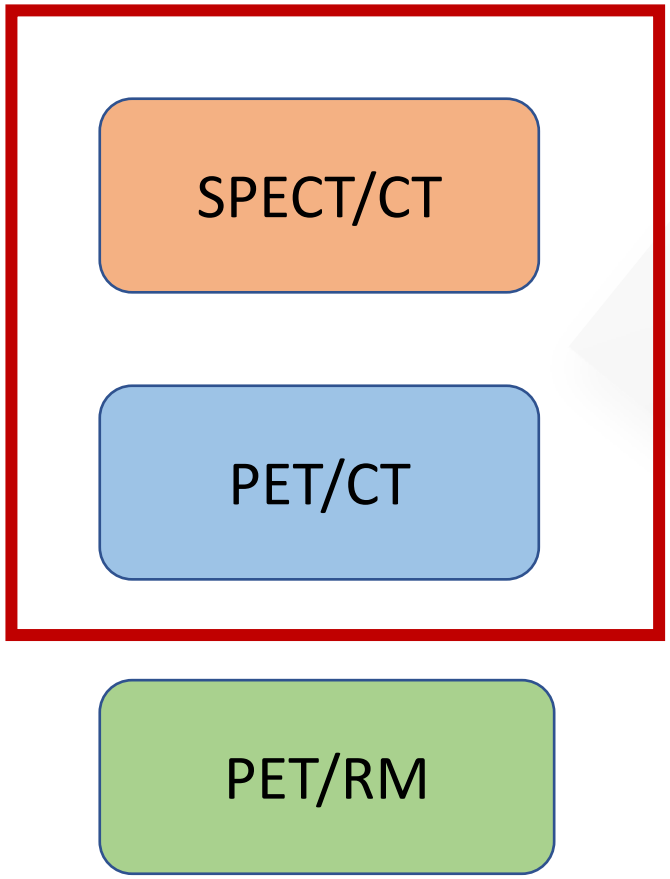


IMAGEN HIBRIDA

TECNICAS HIBRIDAS EN MEDICINA NUCLEAR



NÚCLEO DE QUITO

TECNICAS HIBRIDAS: Conceptos

- Diagnóstico tardío por cambios anatómicos después de instaurada la patología.
- Cambios funcionales o metabólicos, pueden ocurrir en ausencia de correlato anatómico.
- Diagnóstico temprano es la clave. (alteración anatómica podría ser insuficiente para dg oportuno).
- Combinación de técnicas “imagen morfo-metabólica”
- Datos complementarios: TC localiza alteraciones funcionales del SPECT y PET y destaca áreas de metabolismo anormal.
- Un exámen único, amplia información del estado de la patología.

TECNICAS HIBRIDAS: Conceptos

1. Reunir información funcional y anatómica (de baja resolución), amplia información diagnóstica.
2. A pesar del costo superior, beneficio de uso de un solo equipo.
3. Efectos sinérgicos por la adquisición y procesamiento de los datos de imagen.

NÚCLEO DE QUITO

TECNICAS HIBRIDAS: Oncología

- Diagnóstico, valoración de respuesta y seguimiento.

- ***Estructurales:*** localización, tamaño , morfología, cambios estructurales y relación con adyacentes.

(compromiso metastásico temprano de ganglios, cambios postquirúrgicos podrían enmascarar tumor remanente).

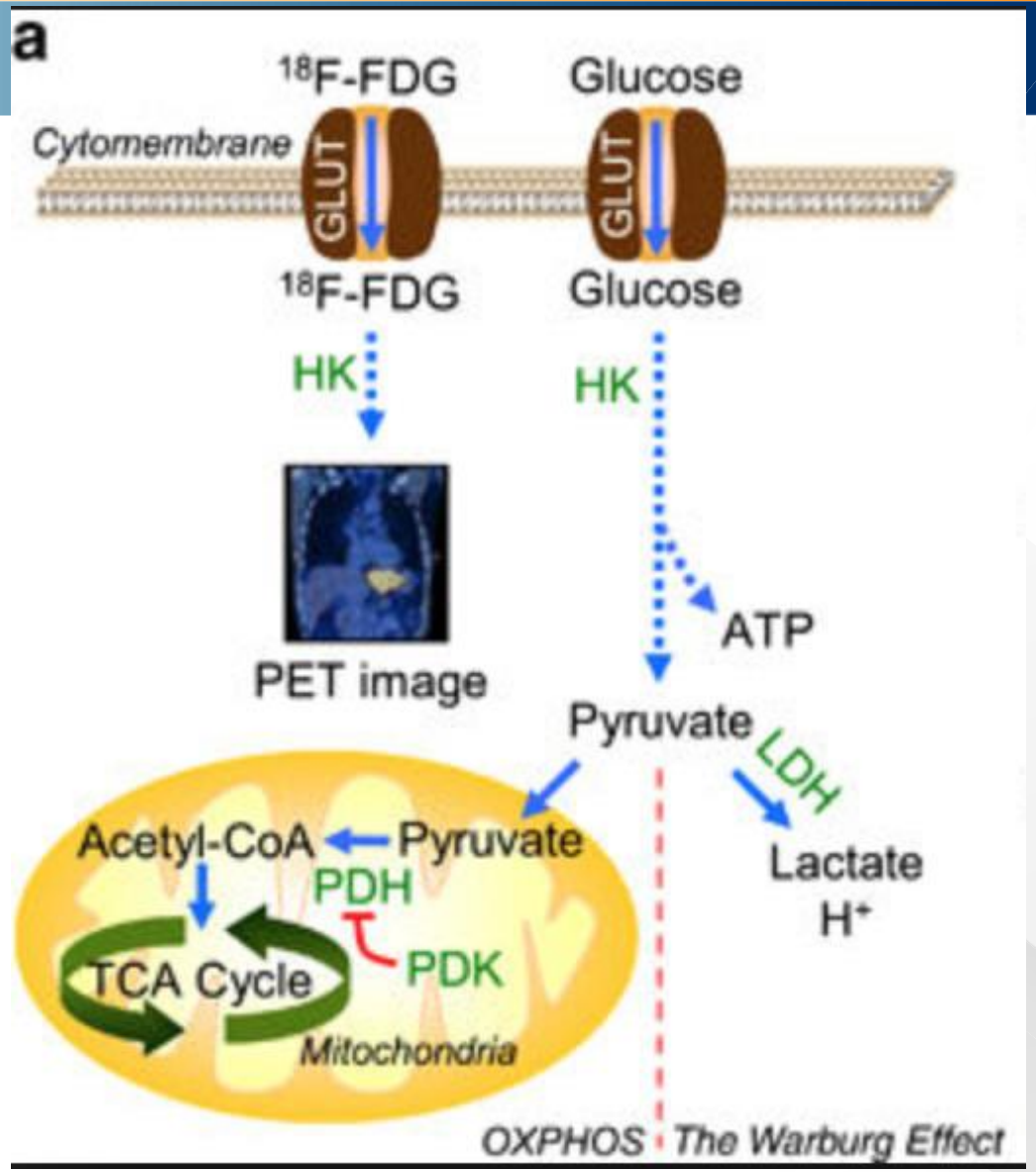
- ***PET y SPECT*** → función biológica y microambiente.

↓

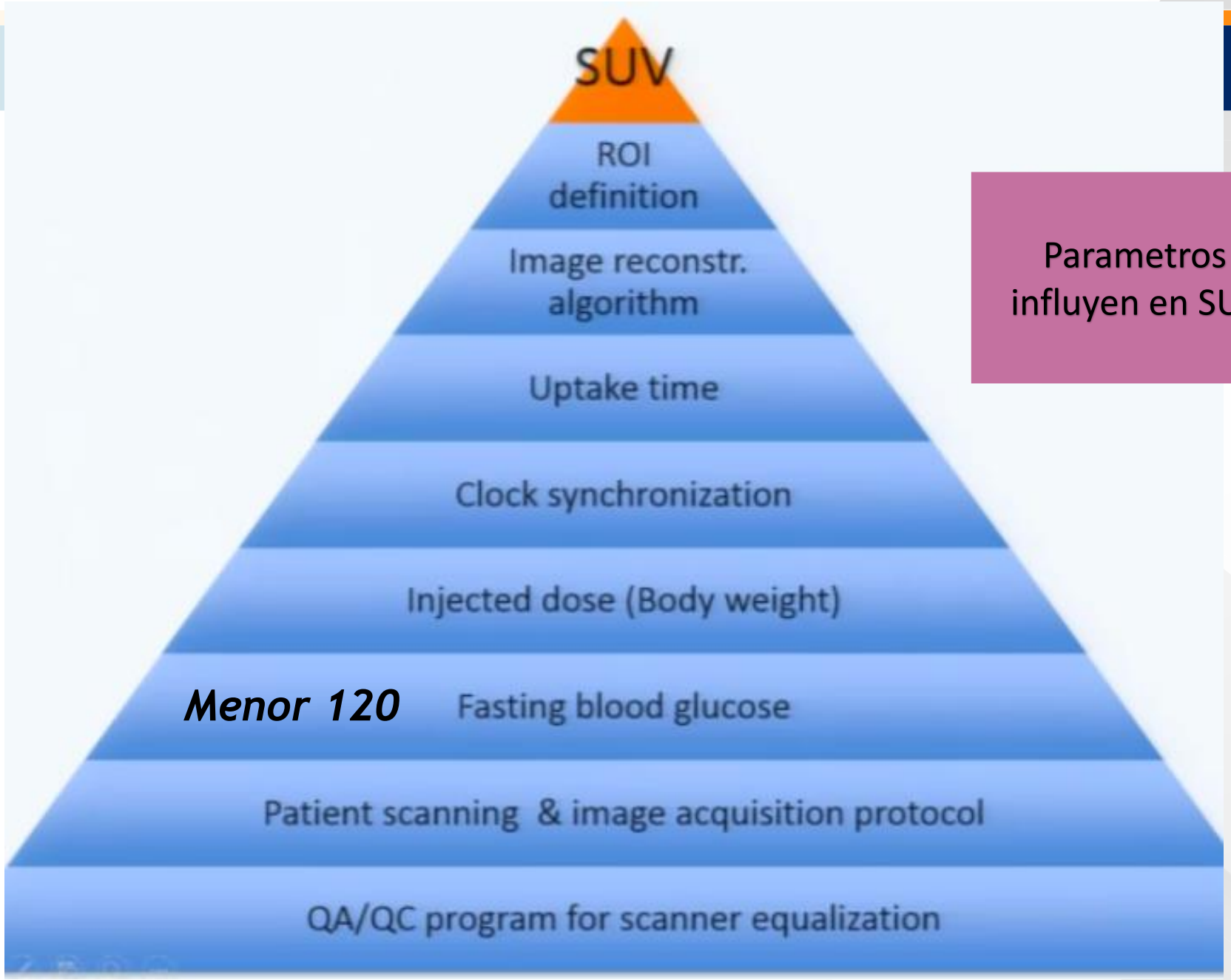
- Simples: limitadas (baja resolución espacial y la incapacidad de detalles anatómicos).

- Localización anatómica de un proceso fisiológico con visualización de la estructura tumoral.

- Conductas terapéuticas y manejo del paciente.



- C GÁMEZ CENZANO, A CABRERA VILLEGAS, R SOPENA MONFORTE, Ma J GARCÍA VELLOSO, La tomografía por emisión de positrones (PET) en oncología (Parte I) Revista española de Medicina nuclear 2002



Parametros que influyen en SUVmax

PET-CT

Captación	De bajo grado	↓
	De alto grado	↑
Aplicaciones	– Guía	
	– Mali	
	– Plan	
	– Segu	
Limitaciones	Lesiones benignas	juvenil
		s o infecciosos
		s
	Lesiones malignas	
		éricas

Tabla III

FACTORES QUE INFLUYEN EN LA CAPTACIÓN CELULAR DE ^{18}FDG

1.- Factores histológicos
- Tejido de granulación peritumoral
- Masa de células viables
- Grado de diferenciación
- Origen histológico
- Forma de crecimiento
- Grado de hipoxia

2.- Factores extrínsecos
- Hiperglucemia
- Tamaño de la lesión
- Localización
- Efecto parcial de volumen
- Tratamientos oncológicos

C GÁMEZ CENZANO*, A CABRERA VILLEGAS, R SOPENA MONFORTE, Ma J GARCÍA VELLOSO, La tomografía por emisión de positrones (PET) en oncología (Parte I), *Revista española de medicina nuclear No. 21*

PET-CT

Tabla IV

EFECTOS DE LOS DISTINTOS TRATAMIENTOS UTILIZADOS EN LOS PACIENTES ONCOLÓGICOS EN LA CAPTACIÓN DE ^{18}FDG EN EL TEJIDO NORMAL Y TUMORAL

TRATAMIENTO	*EFECTO CAPTACIÓN ^{18}FDG*		*APLICACIÓN*	*INTERVALO DE TIEMPO RECOMENDADO*
	Tejido			
	Normal	*Tumoral*		
Cirugía	↑ (reciente) Ø (antigua)	↑ (persitencia)	Enfermedad residual o recidiva precoz	1 mes
Quimioterapia	Ø ↓ (cerebro)	↓ (sensibles)	¿Valorar respuesta?	1,5 meses
Radioterapia	↓ (hueso) ↑ (neumonitis, enteritis rádica)	↓ (sensibles)	¿Valorar respuesta?	3 meses

Ø: no se afecta; ↓: es baja o diminuye; ↑: es elevada o aumenta.

NÚCLEO DE QUITO

REFRACTARIEDAD ^{131}I

- Age, tumor histology, initial stage, radioiodine residual avidity, and 18F-FDG avidity.
- “When, in fact, the patient may respond to a 131I therapy, then that patient has lost the potential benefit of an effective 131I therapy in a situation with limited therapeutic options”
- Unnecessary side effects from an ineffective therapy, but a potentially beneficial alternative therapy is delayed.
- ***Progression after a short time interval after administration of a maximum safe 131I therapeutic activity***
- PT-WBS scan after therapeutic 131I administration (e.g.3–4 d versus 5–7 d) can make the difference in interpretation between a negative and positive PT-WBS.

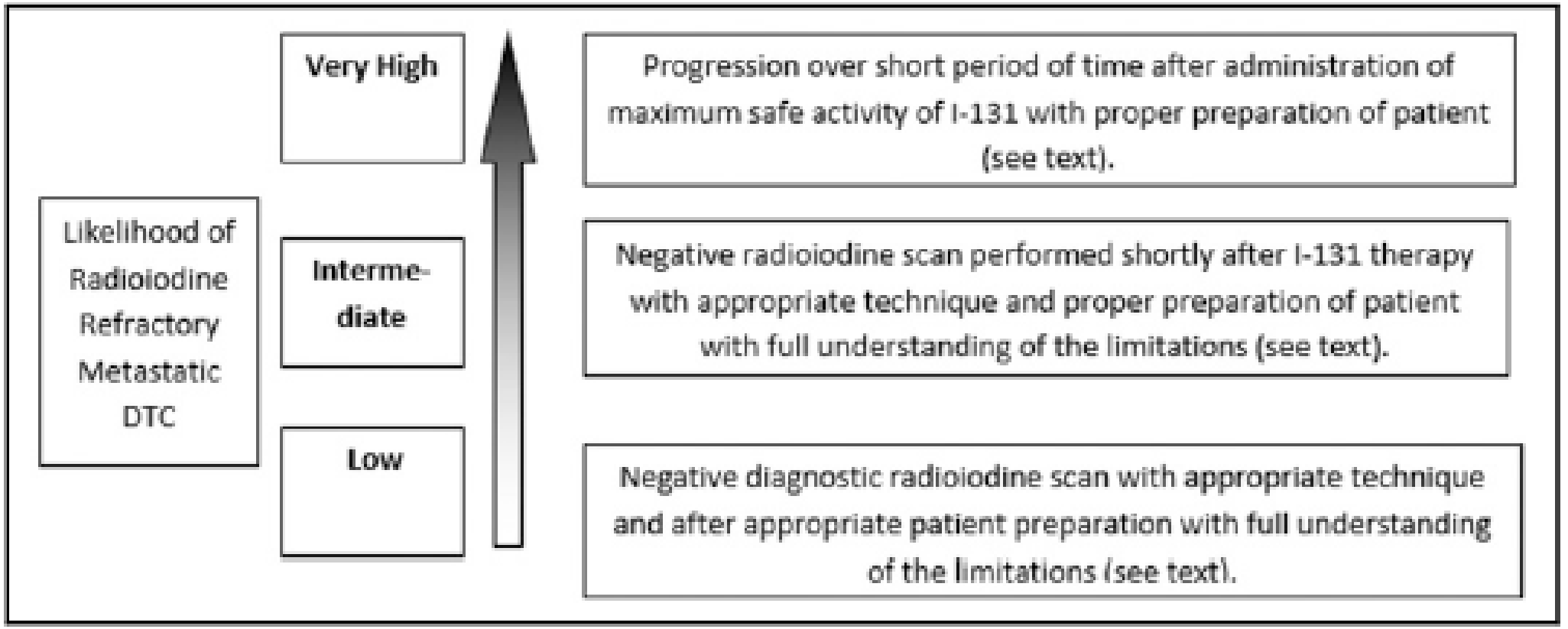


FIGURE 5. Likelihood of radioiodine-refractory differentiated thyroid cancer.

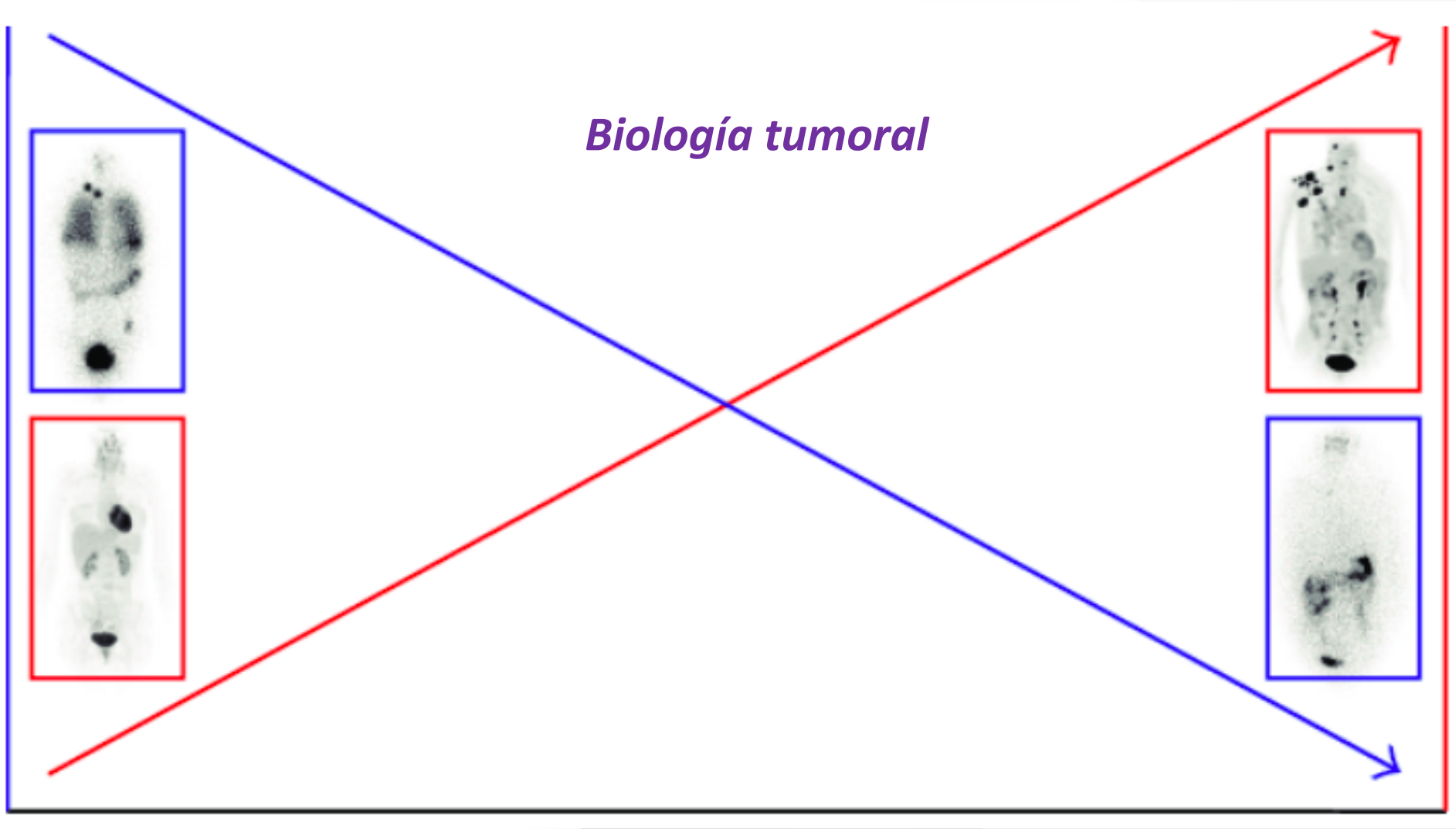
TABLE 6
Caveats Regarding Criteria for Radioiodine-Refractory Metastatic Differentiated Thyroid Cancer (Adapted from [*161*])

- The observation that a patient does not demonstrate radioiodine uptake on a diagnostic scan or posttherapy scan does not necessarily mean that the patient's metastatic disease is radioiodine refractory.
- The observation that a patient does demonstrate radioiodine uptake on a diagnostic scan or posttherapy scan does not necessarily mean that the patient's metastatic disease is responsive to a ^{131}I therapy.
- As the total accumulative activity of administered ^{131}I increases, the likelihood of a response to a subsequent ^{131}I therapy decreases. However, no maximum accumulated threshold of administered ^{131}I activity should designate a patient's metastatic disease as radioiodine refractory.
- One metastatic *lesion* that is classified as *radioiodine refractory* does not necessarily mean the *patient* is now *radioiodine refractory*. Combination therapy of direct focal therapy (e.g., surgery, external-beam radiotherapy, radiofrequency ablation, cryotherapy, embolization, radioisotope embolization) or/with targeted therapy (e.g., tyrosine kinase inhibitors, BRAF inhibitors, etc.) in combination with ^{131}I therapy may benefit the patient.
- Progression, in and of itself, is not a criterion that a ^{131}I therapy has "failed" and that a patient's metastatic disease is "radioiodine refractory." Additional factors, such as duration of progression-free survival and administered activity of ^{131}I are important.

DOSIS INICIAL ADECUADA

NÚCLEO DE QUITO

Fenómeno FLIP FLOP



NÚCLEO DE QUITO

- ***Type I:*** negative 131I/positive FDG uptake and is the most commonly encountered pattern in patients with elevated Tg and negative scintigraphy (i.e., Tg1/scan–), 46% cases.
- ***Type II:*** positive 131I/negative FDG uptake and represents the most favorable context for therapeutic 131I administration.
- ***Type III:*** combination of type I and II patterns recognized in different metastatic lesions within the same patient (varying biologic behavior in metastatic foci).
- ***Type IV:*** uptake of both 131I and 18FDG within the same metastatic lesions

ANTES DE DAGNOSTICAR RCT NEGATIVO

- Screening for a history of recent iodine load, such as recent administration of radiologic contrast agents or ingestion of kelp, as well as administration of amiodarone, even months to years earlier.

- Confirming compliance with LID as demonstrated by low urinary iodine levels (e.g., spot urine iodine level, spot urine I/Cr, or 24-h urine iodine collection)

- Ascertaining adequate TSH elevation, which is especially important with preparation by THW

- Excluding heterophilic antibody interference on Tg measurement (prevalence 0.4%–1%)

Minimize false-negative radioiodine scans

- Confirming correct radiopharmaceutical administration (reviewing documents for appropriate isotope and prescribed activity and reviewing the scan images themselves for inappropriate distribution of radioactivity)

- Confirmingtechnical scan parameters (collimator type, peaking of energy window, table speed for planar scan, time interval for stop position for SPECT acquisition, etc).

NÚCLEO DE QUITO

ANTES DE DAGNOSTICAR RCT NEGATIVO

Dynamic risk restratification:

- Physical exam
- Tg, TgAb, and TSH testing
- US of the thyroid bed and neck. However, nonradioiodine imaging is indicated when the patient has an intermediate or higher risk for disease recurrence.

NÚCLEO DE QUITO

ANTES DE DAGNOSTICAR RCT NEGATIVO

Otros estudios de imagen:

1. Neck US
2. 18F-FDG PET/CT imaging
3. CT of the neck, chest, abdomen, and pelvis

TABLE 8

Factors Considered for Management of Elevated Tg and Negative DxWBS (Tg+/Scan–) Patients

- Treatment objectives (i.e., cure, progression-free survival, palliation)
- Time interval since last ^{131}I treatment
- Amount of ^{131}I activity administered for most recent treatment
- Response to most recent ^{131}I treatment (if there has been a previous therapy)
- Total cumulative ^{131}I therapeutic activity
- Frequency and severity of side effects of prior ^{131}I therapies
- Is the patient a minimalist or maximalist regarding benefit vs risk of ^{131}I therapy?
- Comorbidities
- Capabilities of the treating facility

- Anca M. Avram, Luca Giovanella, Alexis Vrachimis. SNMMI Procedure Standard/EANM Practice Guideline for Nuclear Medicine Evaluation and Therapy of Differentiated Thyroid Cancer. The journal of nuclear medicine. June 2022. Vol 63. No 6

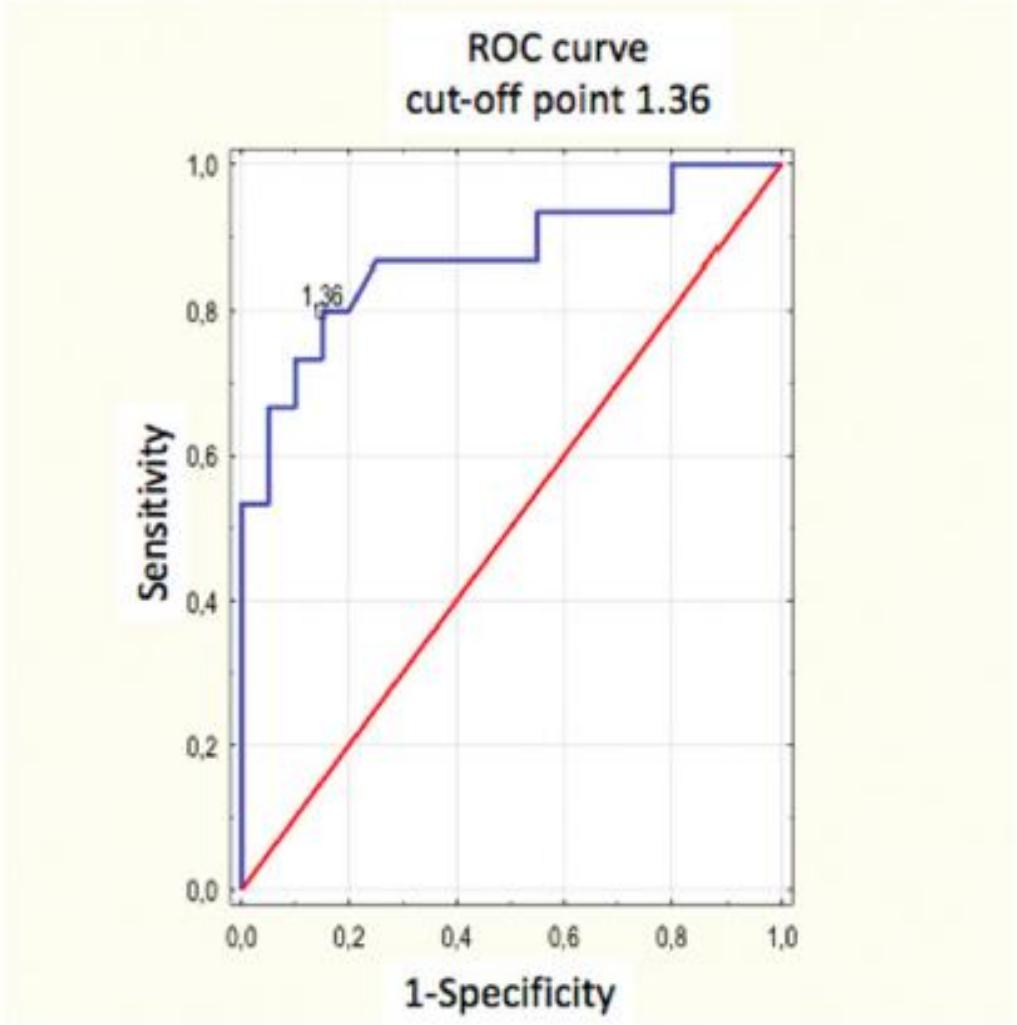


Figure 4. The ROC curve for natTg in the prediction of positive result of PET/CT

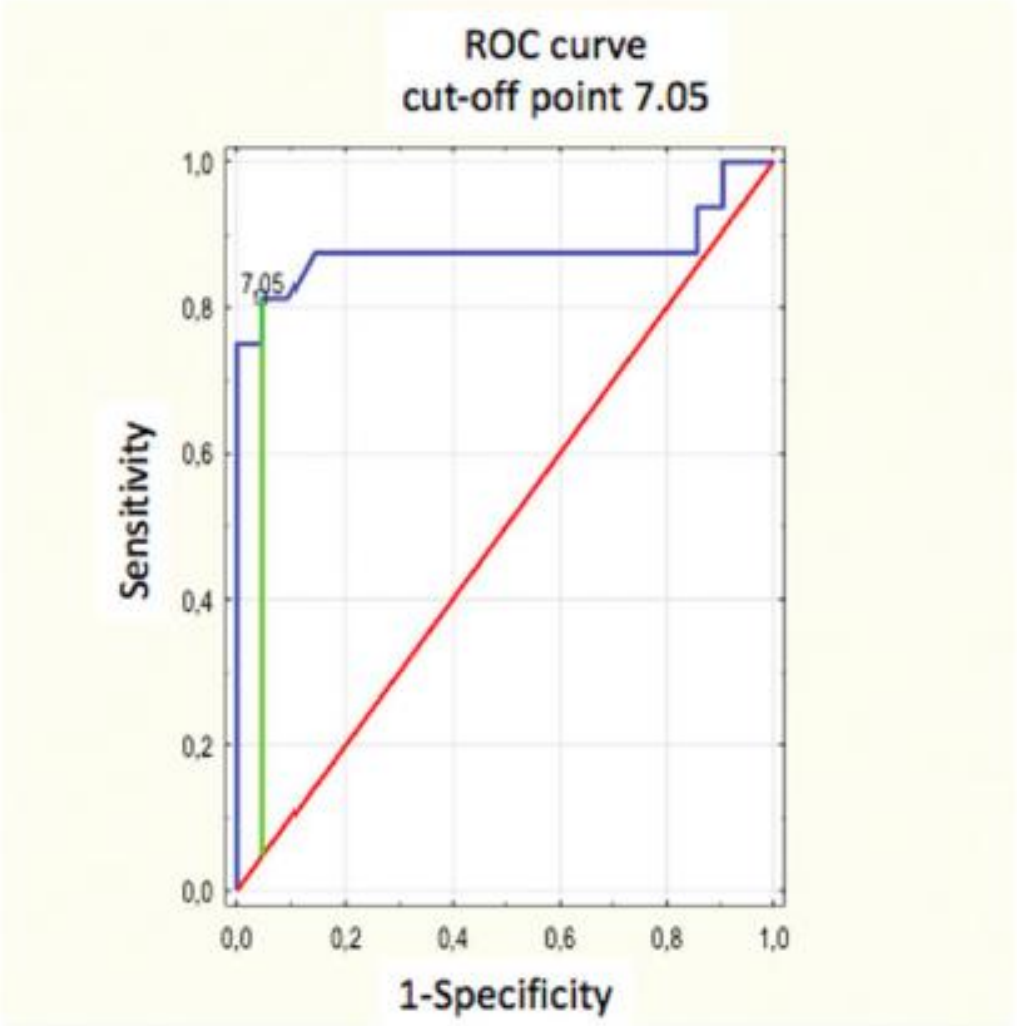


Figure 5. The ROC curve for sTg in the prediction of positive result of PET/CT

Maciej Kolodziej, Marek Saracyn, Arkadiusz Lubas, Dorota Brodowska-Kania, Andrzej Mazurek, Miroslaw Dziuk, Jolanta Dymus, Grzegorz Kaminski, Evaluation of the usefulness of positron emission tomography with [18F]fluorodeoxylglucose performed to detect non-radioiodine avid recurrence and/or metastasis of differentiated thyroid cancer — a preliminary study, Nuclear medicine review 2021.

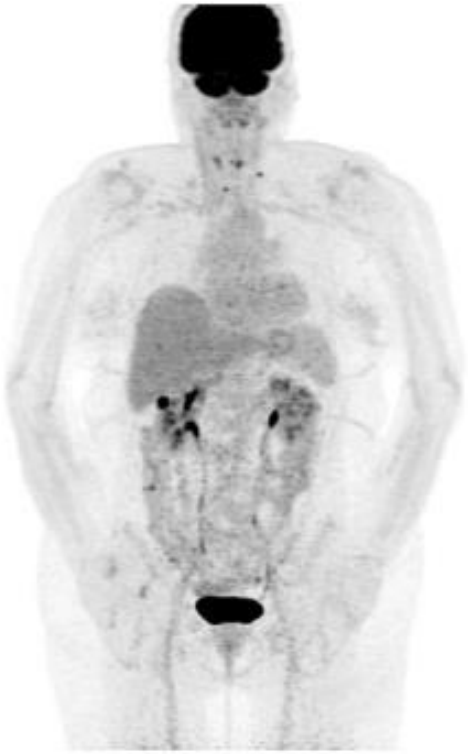


Figure 1A. PET/CT maximum intensity projection (MIP) performed under TSH suppression — accumulation of the [^{18}F]FDG in the left cervical and right mediastinal lymph nodes

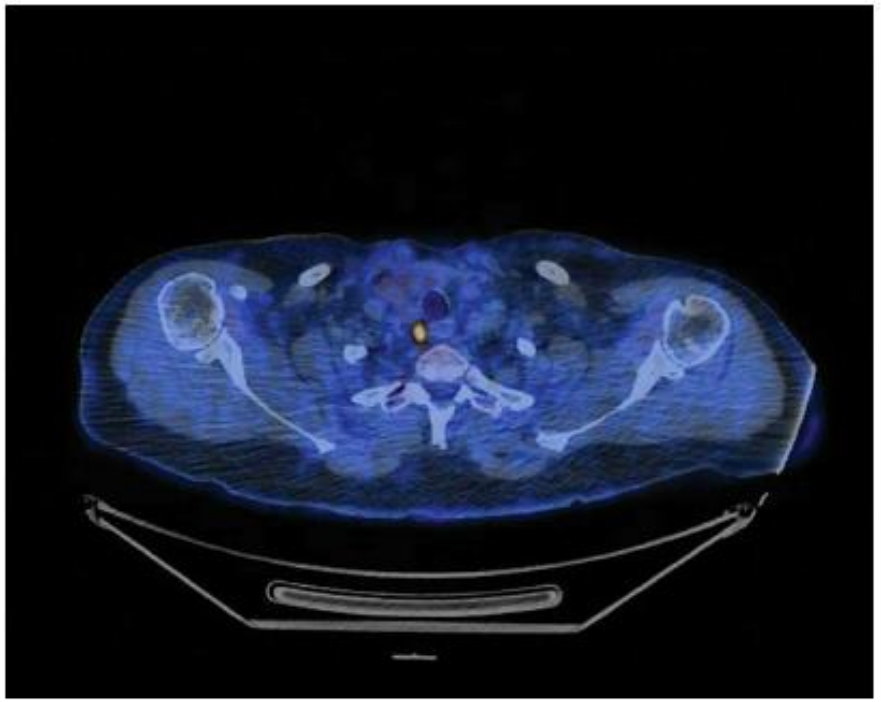


Figure 1B. PET/CT axial fusion projection performed under TSH suppression — accumulation of the [^{18}F]FDG in the right mediastinal lymph node

Maciej Kolodziej, Marek Saracyn, Arkadiusz Lubas, Dorota Brodowska-Kania, Andrzej Mazurek, Miroslaw Dziuk, Jolanta Dymus, Grzegorz Kaminski, Evaluation of the usefulness of positron emission tomography with [18F]fluorodeoxylglucose performed to detect non-radioiodine avid recurrence and/or metastasis of differentiated thyroid cancer — a preliminary study, Nuclear medicine review 2021.

Figure 2A. PET/CT maximum intensity projection (MIP) performed under TSH suppression — multiple pulmonary metastasis

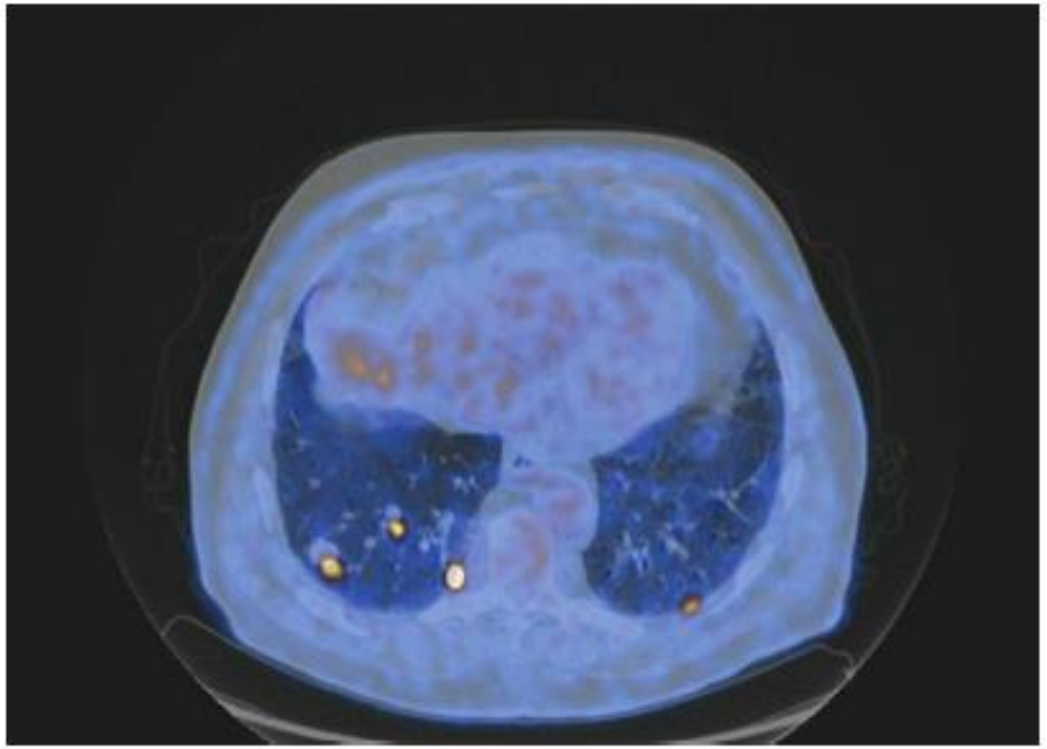


Figure 2B. PET/CT maximum intensity projection (MIP) performed under TSH suppression — multiple pulmonary metastasis

Maciej Kolodziej, Marek Saracyn, Arkadiusz Lubas, Dorota Brodowska-Kania, Andrzej Mazurek, Miroslaw Dziuk, Jolanta Dymus, Grzegorz Kaminski, Evaluation of the usefulness of positron emission tomography with [18F]fluorodeoxylglucose performed to detect non-radioiodine avid recurrence and/or metastasis of differentiated thyroid cancer — a preliminary study, Nuclear medicine review 2021.

NÚCLEO DE QUITO

18F-FDG PET/CT

INDICACIONES:

- Localización y extensión de la enfermedad (↑Trg, RCT -)
- Elevación desproporcionada de l enfermedad.
- Estadificación inicial y seguimiento en HP agresivos (Cel Hurttle, pobremente o desdiferenciado)
- Biomarcador pronóstico (agresividad)
- Valoración de respuesta al tratamiento

NÚCLEO DE QUITO

VALOR PRONOSTICO

- *Prognostic value for survival in metastatic DTC (survival disadvantage)*
- *Predicted a 7-fold increased risk of mortality*
- **MTV** (> 125 ml) y **TLG** (imaging biomarkers for prognosis in human solid tumors).
- Higher MTV and TLG values were associated with worse OS and PFS (3.5 y for patients with radioiodinerefractory metastatic DTC).

18F-FDG PET/CT como biomarcador pronóstico

Survival:

- RAI+, FDG -: 95% DSS
- RAI+, FDG+: 45% DSS
- RAI-, FDG+: 45% DSS

Robbins, et al. JCEM 2006

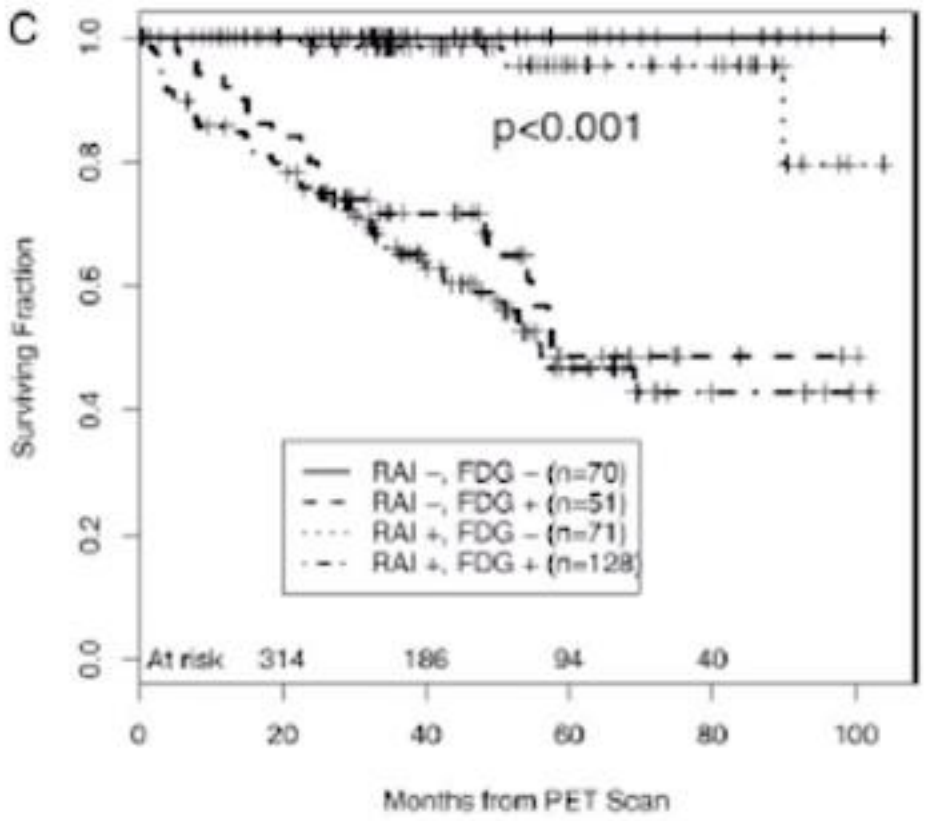
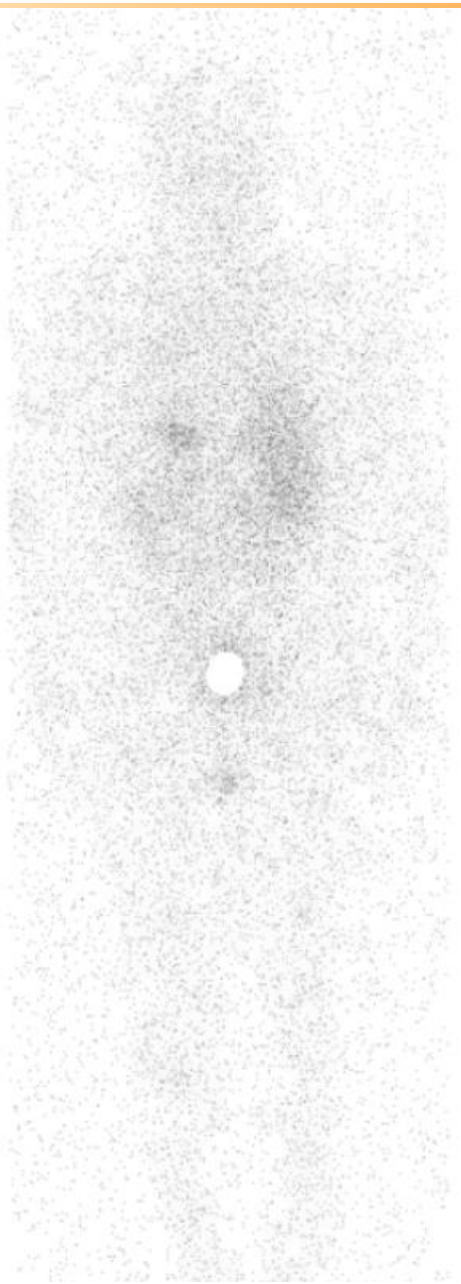
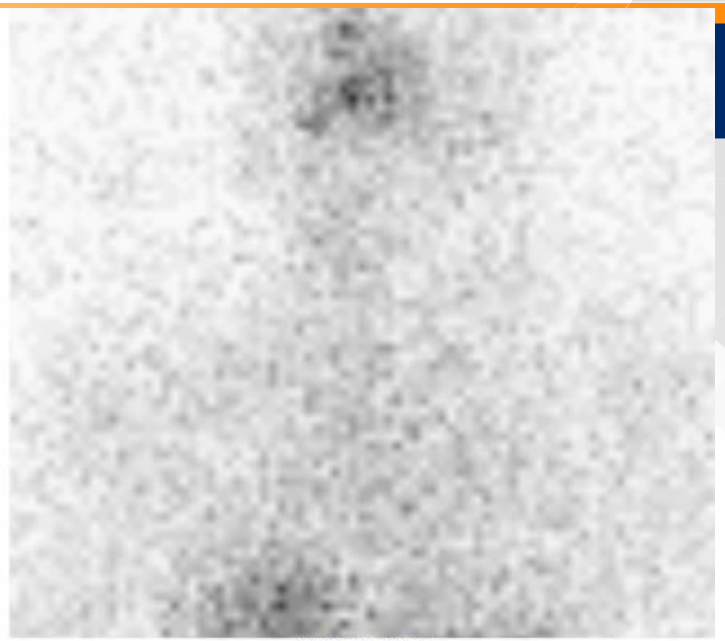


FIG. 2. Kaplan-Meier survival plots of thyroid cancer patients based on radioactive iodine scanning (A), FDG-PET scanning (B), and combination scanning (C). –, Scan negative; +, scan positive.





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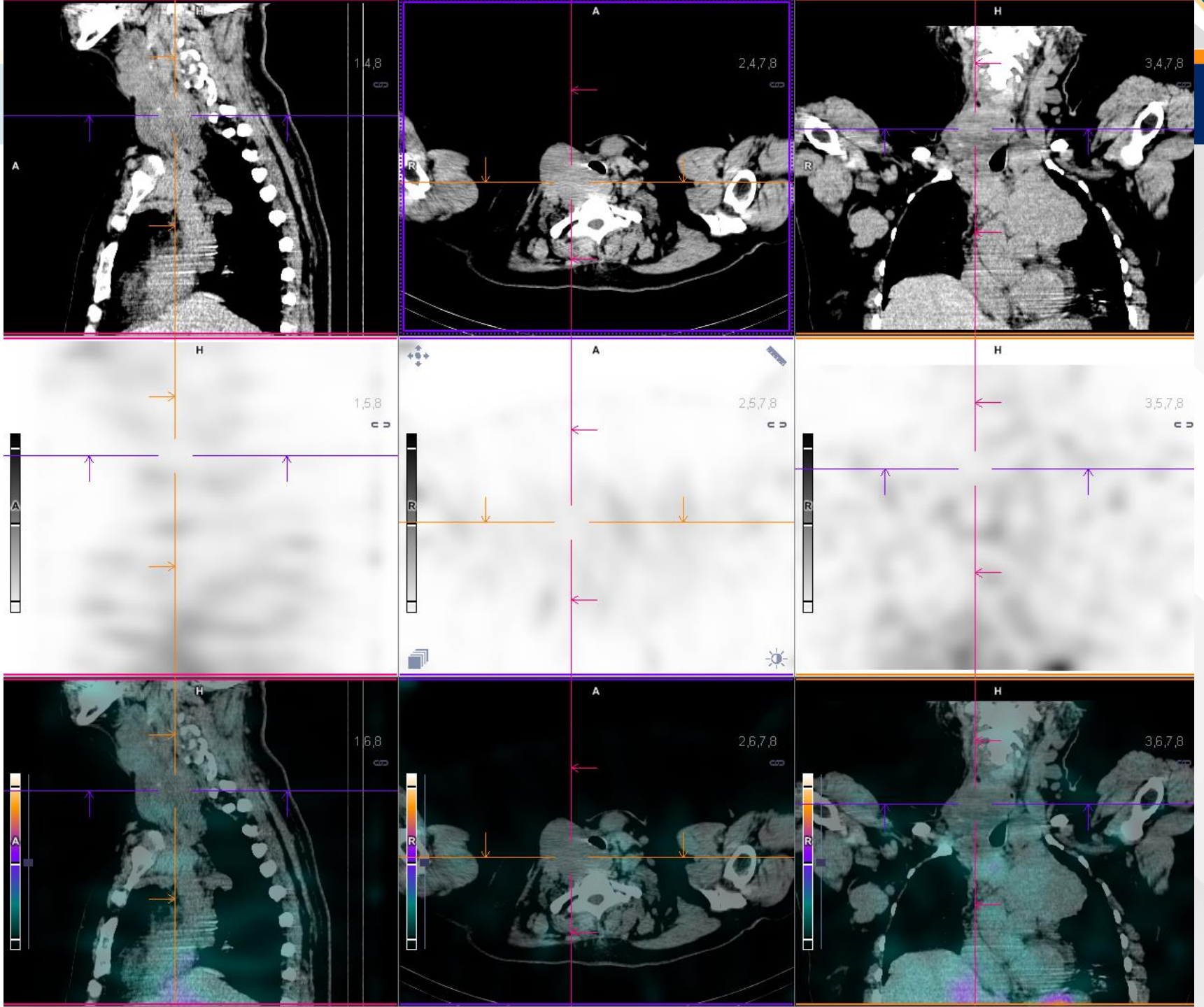
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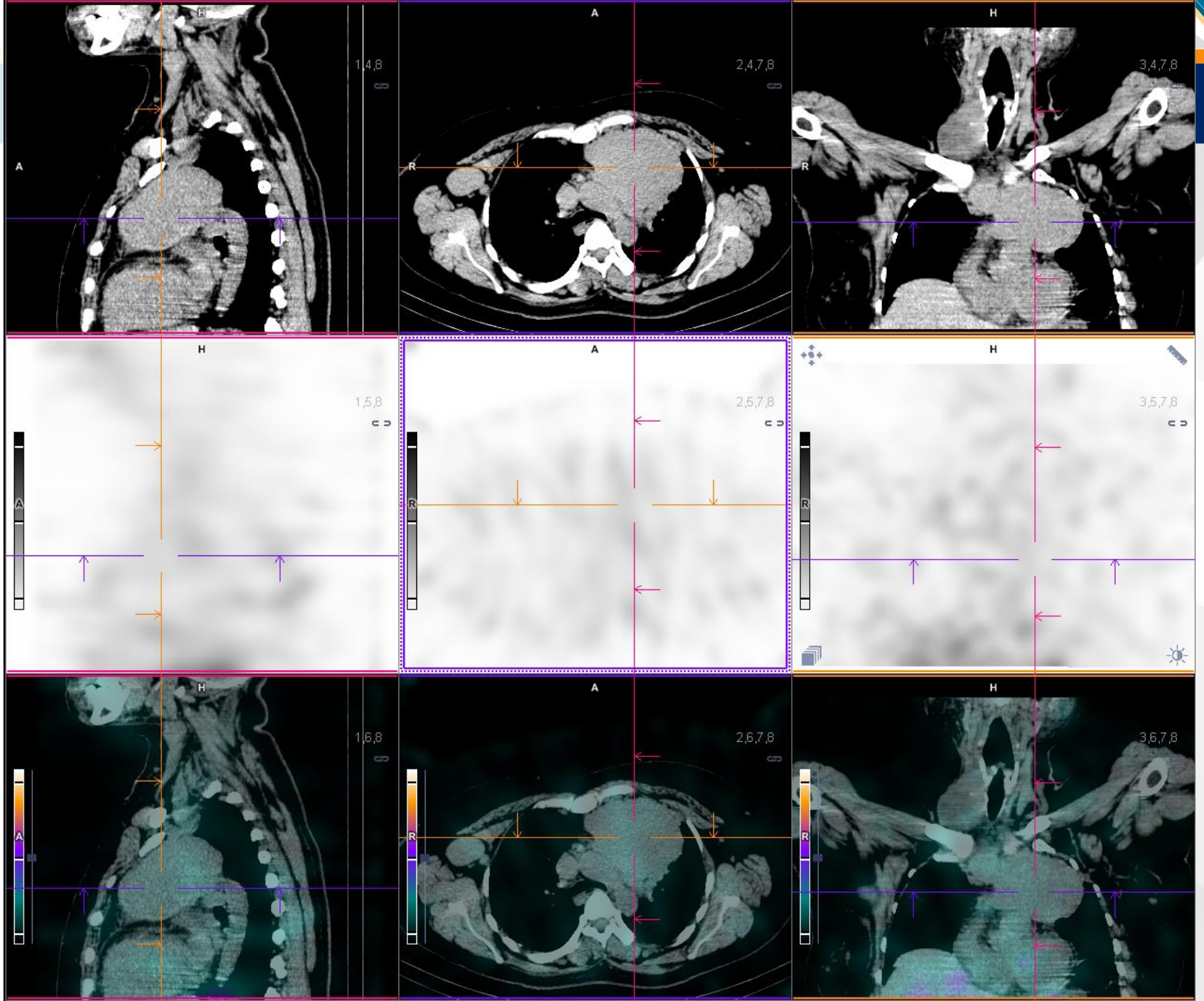
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H
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R

NÚCLEO DE QUITO

TAKE HOME MESSAGES

- La ausencia de capatción No debe definirse como criterio de refractariedad por sí sola.
- PET/CT con 18F-FDG en elevación desproprocionada del marcador.
- Valor pronóstico SO, PFS, DSS
- Blomarcadores pornósticos (MTV, TLG)
- Radiofaramcos PET/CT no 18F-FDG

NÚCLEO DE QUITO

Gracias!