



Roma, 9-12 novembre 2017

Guida all'iperparatiroidismo (HPT)



ITALIAN CHAPTER



Tecniche di localizzazione

AZIENDA OSPEDALIERA
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Perché localizzare



ITALIAN CHAPTER

Parathyroid imaging has no role in the diagnosis of HPT, which is based on biochemical and clinical data; thus, a negative parathyroid scan does not exclude a diagnosis of HPT.

Instead, parathyroid imaging plays a very important role in the preoperative identification of hyperfunctioning parathyroid gland(s) in HPT patients who are candidates for surgery and in helping the surgeon to find the most appropriate approach, thus reducing operating times and limiting complications and surgical failure.



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Perché localizzare



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Nel 1986 il radiologo interventista John L. Doppman affermava: «The only localising study indicate in untrated primary hyperparathyroidism is to localise an experienced parathyroid surgery»

Trattamento standard: ***bilateral neck exploration*** con visualizzazione diretta di tutte e quattro le ghiandole



Perché localizzare



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Unilateral Versus Bilateral Neck Exploration for Primary Hyperparathyroidism A Prospective Randomized Controlled Trial

Anders Bergenfelz, MD, PhD, Pia Lindblom, MD, PhD, Sten Tibblin, MD, PhD, and Johan Westerdahl, MD, PhD

From the Department of Surgery, Lund University Hospital, Lund, Sweden

Ann. Surg. • November 2002

Conclusions

Patients undergoing a unilateral procedure had a lower incidence of biochemical and severe symptomatic hypocalcemia in the early postoperative period compared with patients undergoing bilateral exploration. Unilateral neck exploration with intraoperative parathyroid hormone assessment is a valid surgical strategy in patients with primary hyperparathyroidism with distinct advantages, especially for patients with solitary parathyroid adenoma.



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Perché localizzare



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The Superiority of Minimally Invasive Parathyroidectomy Based on 1650 Consecutive Patients With Primary Hyperparathyroidism

*Robert Udelsman, MD, MBA, FACS**, *Zhenqiu Lin, PhD†*, and *Patricia Donovan, RN, MBA**

This prospective study represents one of the largest series of patients who underwent treatment of PHPT by a single surgeon. The data indicate that MIP is a superior technique in select patients with sporadic disease. It is associated with an improved cure rate and decreases in the complication rate, hospital length of stay, and total hospital charges. It is ideally suited for patients who have a single parathyroid adenoma identified on preoperative imaging. However, optimal imaging is not a requisite for MIP. The result of this experience argue strongly for the adoption of minimally invasive techniques for the treatment of sporadic PHPT.

Annals of Surgery • Volume 253, Number 3, March 2011



Chi localizzare

Le Paratiroidi: anatomia ed embriologia

Parathyroid gland size, number, and location are some of the **most variable features** of human anatomy.

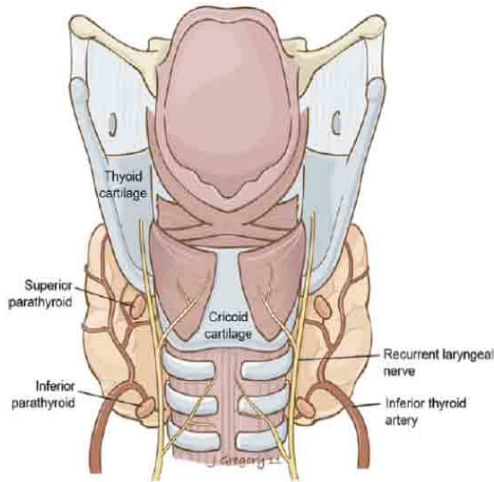
The most typical arrangement is of 2 sets of paired glands adjacent to the posterior thyroid gland.

Normal parathyroid glands have a weight of 20–40 mg and are 5–10 mm in length, 2–4 mm in width, and 0.5–2 mm thick.

Normal glands can range in weight from 18–161 mg; however, glands of 60 mg are usually considered abnormal, with most parathyroid adenomas weighing more than 100 mg. (It is not unusual for normal glands to be smaller in patients with PTH hypersecretion from an adenoma due to negative feedback).

Most glands are ovoid or beanshaped, but elongated and multilobed glands are not uncommon.

Supernumerary glands occur in up to 13% of patients





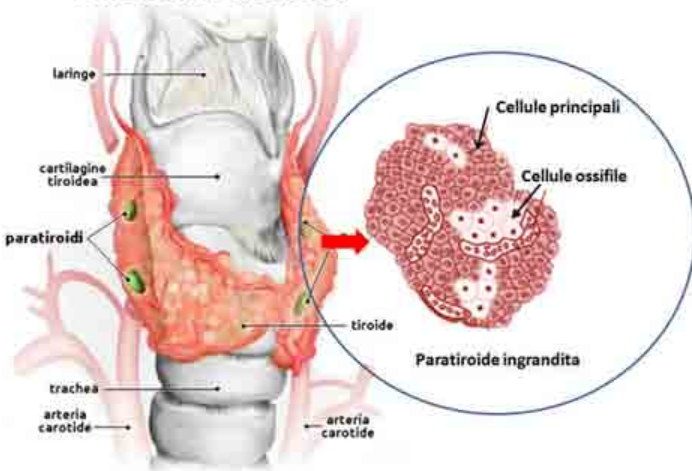
Le Paratiroidi: anatomia ed embriologia



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Ghiandole Paratiroidi



Within the parathyroid glands there are **two main glandular components**: parenchymal cells and fat cells.

The proportions of these two kinds of cells vary with age: in young people, there are only a few sparse fat cells, which increase gradually and about the age of 30 years fat cells constitute 10–25% of the glandular volume. After this age the proportion of fat cells remain relatively constant.

The parenchymal cells are mainly **chief cells**, the functional part of the glands. The chief cells, as active endocrine cells that produce the PTH, have slightly eosinophilic cytoplasm and few mitochondria. The other parenchymal cells are **oxyphilic cells**, which may be able to produce PTH, **transitional oxyphilic cells**, a variant of oxyphilic cell, and **clear cells** with unknown function, fundamentally inactive

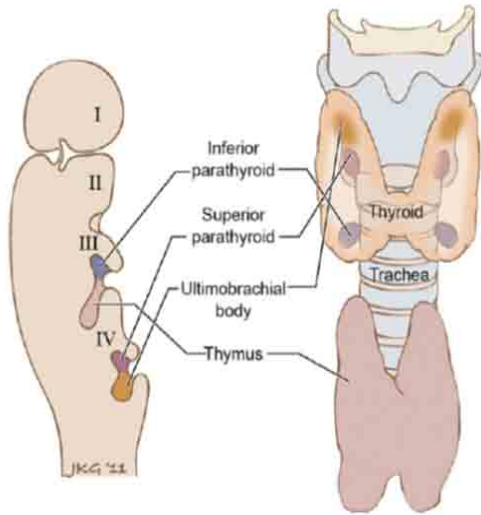


Le Paratiroidi: anatomia ed embriologia



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The **superior glands** are derived from the **fourth branchial pouch** and are less variable in location owing to their shorter descent during embryological development, with approximately 80% located posterior to the mid-portion of the thyroid at the level of the cricoid cartilage.

The **inferior glands**, derived from the **third branchial pouch** along with the thymus, are typically located posterior to the inferior pole of the thyroid but are **more inconsistent in location** due to their lengthier migration.



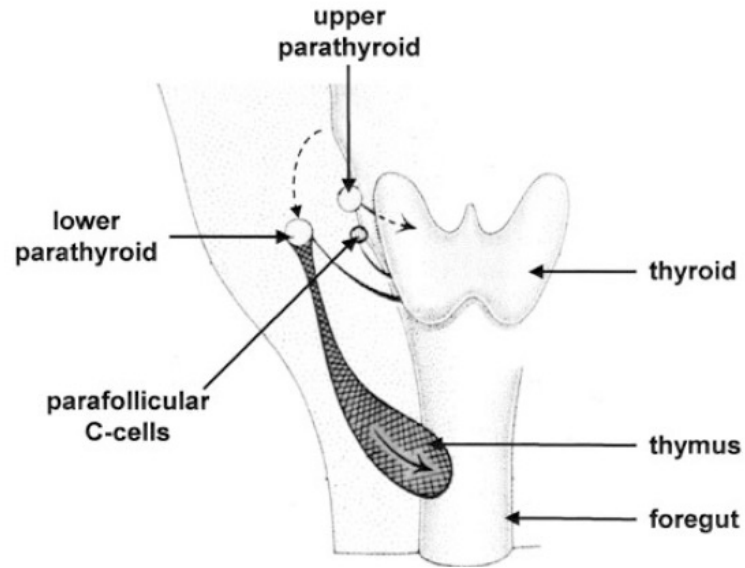
Le Paratiroidi: anatomia ed embriologia



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The location of ectopic glands is directed by embryological relationships.



Ectopic superior glands are most commonly found within the thyroid gland or capsule because the parafollicular cells of the thyroid are also derived from the fourth branchial pouch, whereas ectopic inferior glands can be located anywhere along their shared descent with the thymus from the third pouch, including the thyrothymic ligament and within the thymus itself.

Other less common ectopic locations include undescended glands high in the neck or carotid sheath, retroesophageal locations, and within the mediastinum.



Le Paratiroidi: anatomia ed embriologia



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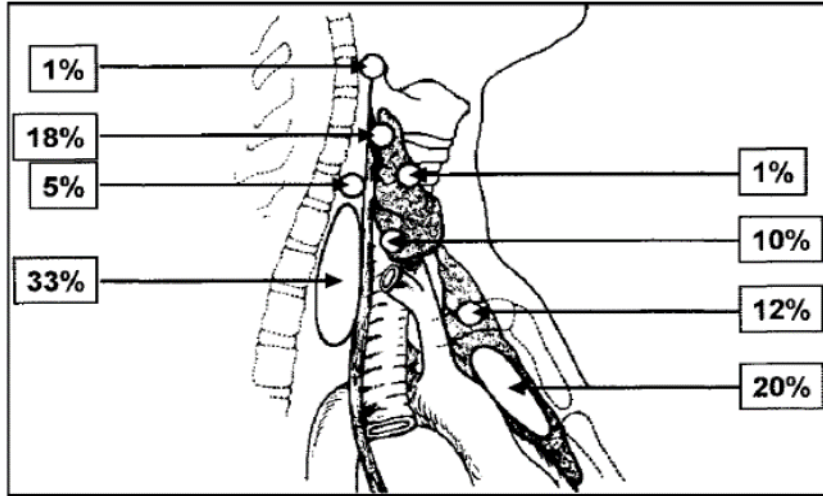
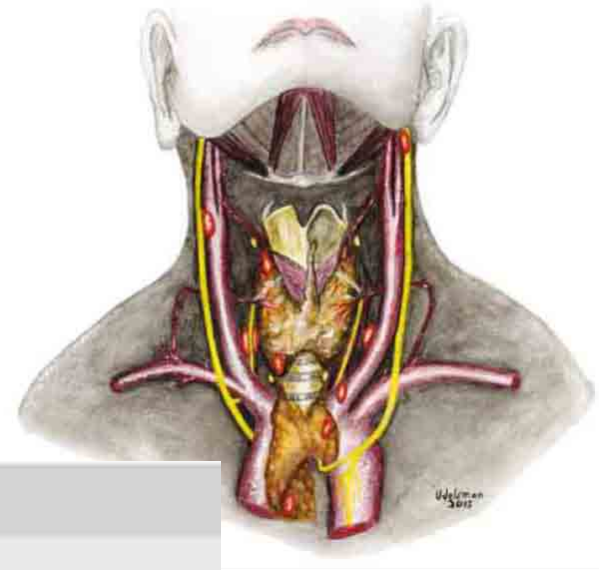


Figure 1. Anatomical Relationships of Eutopic and Ectopic Parathyroid Glands



Hodgson 2012

Inferior parathyroids

1. Thymus gland
2. Thyroid gland
3. Thyrothymic ligament
4. Submandibular

Superior parathyroids

1. Tracheoesophageal groove
2. Retroesophageal region
3. Posterosuperior mediastinum
4. Paraesophageal region
5. Thyroid gland
6. Carotid sheath

Rare locations

1. Carotid bifurcation
2. Posterior triangle of the neck
3. Within the vagus nerve
4. Within the hypoglossal nerve
5. Pericardium
6. Right dome of the diaphragm
7. Supraclavicular region



Paratiroidi: patologia



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HPT can be due to a hyperplastic or neoplastic disease of parathyroid gland(s), more frequently adenomas, most rarely carcinomas.

About **85%** of HPT is caused by a solitary **adenoma** of the parathyroid glands: this is a benign tumour that can vary in weight from less than 100 mg to more than 100 g (there is some correlation between adenoma size and the degree of hypercalcaemia).

Microscopically, the adenoma is surrounded by a rim of normal parathyroid tissue outside the capsule. It is formed predominantly of chief cells that are usually enlarged with nuclei larger and more variable in size compared to normal parathyroid tissue. The nuclear pleomorphism is not a sign of malignancy, but it is considered a criterion to differentiate adenoma from hyperplasia.

In about 5% of cases typical adenomas affect **more than one gland**, “double adenomas”



Paratiroidi: patologia



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Parathyroid hyperplasia causes less than **15%** of HPT.

Chief cell hyperplasia is the most common type and it is characterized by a mixture of chief cells and to a lesser extent oxyphil cells.

The cells are arranged in a diffuse pattern or in nodules; sometimes there is a mixture of both patterns. In HPT hyperplasia affects the glands **asymmetrically**, to varying degrees, and commonly one or two glands may be of normal size.

Carcinoma of parathyroid glands represents **less than 1%** of cases of HPT and can arise in any gland, usually in patients between the age of 30 and 60 years and it is generally accompanied by clinical signs of hyperparathyroidism. Unlike an adenoma it is not capsulated, it is larger and appears lobulated, firm and often adherent to the surrounding structures



Paratiroidi: patologia



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HPT can be **sporadic** or **familial**.

The familial form can affect parathyroid glands exclusively or, more often, be part of a multiple endocrine syndrome (MEN): in particular **MEN1** which includes hyperparathyroidism, pituitary tumours and pancreatic neuroendocrine tumours

MEN2A characterized by hyperparathyroidism, medullary thyroid cancer and pheochromocytoma.

In multiple endocrine syndrome with hyperparathyroidism the disease usually involves more than one parathyroid gland (**parathyroid hyperplasia**).

In the case of recurrent hyperparathyroidism a MEN syndrome must be suspected.



Come localizzare: strumenti



ITALIAN CHAPTER

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- **Imaging** di **I livello**
- Ecografia
- Scintigrafia con sesta-MIBI

- **Imaging** di **II livello**
- TC 4D/RM
- PET-TC



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Come localizzare: strumenti



ITALIAN CHAPTER



Evaluation of patients with combined modalities is gaining clinical importance.

Combined interpretation of scintigraphy and US, or scintigraphy and CT, can **improve the diagnostic interpretation of parathyroid scintigraphy and clinical decision making.**



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Come localizzare: strumenti



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Diagnostic Modalities

1. Neck ultrasound (US)
2. ^{99m}Tc Sestamibi scan
3. Computerized tomography
4. Magnetic resonance imaging
5. Single photon emission computed tomography (SPECT)
6. Dual-phase ^{99m}Tc -sestamibi/ $^{99m}\text{TcO}_4$ planar scintigraphy (combination with US, and SPECT)
7. Fine needle-aspiration cytology

Sensitivity

1. 27–89%
2. 54–100% (mostly 80–90%)
3. 65%
4. 75–78%
5. 95%
6. 96%
7. 70%



Come localizzare: strumenti



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Imaging di I livello

Ecografia

Scintigrafia con sesta-MIBI



Ecografia paratiroidea



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- Vantaggi
 - Presenza «*in office*» e basso costo
 - Caratterizzazione del quadro morfo-strutturale tiroideo
 - Non uso di radiazioni ionizzanti
 - Possibilità di eseguire FNAC (dosaggio di PTH su liquido di lavaggio)

Ecografia paratiroidea



ITALIAN CHAPTER

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- Come si esegue
 - Sonde lineari multifrequenza
 - Paziente a capo iperesteso con cuscino dietro le spalle
 - L'esplorazione deve essere estesa dal VII livello cervicale alla regione timica ed al compartimento laterale del collo (localizzazioni pericarotidee, perivagali o all'angolo mandibolare)



Ecografia paratiroidea



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Come si presenta una adenoma paratiroideo

- Lesione nodulare ipoecogena retro o sotto-tiroidea possibile componente anecogena in caso di formazioni voluminose con componente necrotica

Scansione d'approccio trasversale (assiale)

- area delimitata anteriormente dal margine posteriore del lobo tiroideo e della carotide, medialmente dalla parete tracheale, posteriormente dall'esofago e dal muscolo lungo del collo



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Ecografia paratiroidea



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- Scansione longitudinale (sagittale)
 - Profilo, dimensioni e rapporti anatomici della lesione
 - Le P4: passaggio tra terzo medio e terzo superiore del lobo tiroideo; localizzazione generalmente più profonda
 - Le P3: polo tiroideo inferiore in in posizione più caudale, a contatto con il piano muscolare superficiale
- La vascolarizzazione -> Color-Doppler
 - Pattern a canestro
 - Pattern ilare

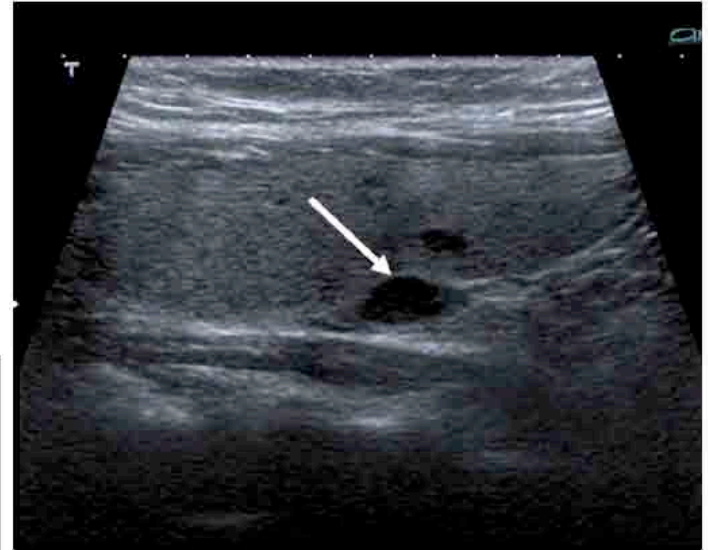
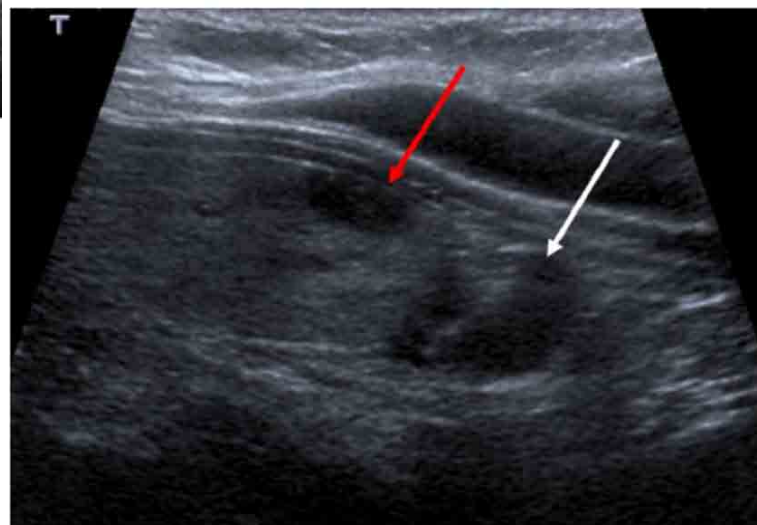
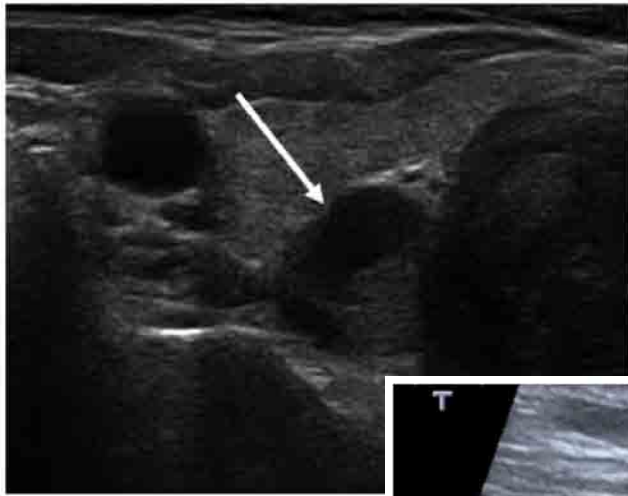


Ecografia paratiroidea



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Ecografia paratiroidea



ITALIAN CHAPTER



- **Fattori limitanti**

- Anomalie di sede anatomiche

- Problematiche quelle retrotracheali e retro-esofagee nonché nel mediastino

- Patologia multi-ghiandolare

- Aspetto ecografico atipico dell'adenoma

- Il 20-30% morfologia inconsueta con profilo allungato di tipo tubulare i bilobato
 - Componente cistica dominante



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Come localizzare: strumenti



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Imaging di I livello

Ecografia

Scintigrafia con sesta-MIBI

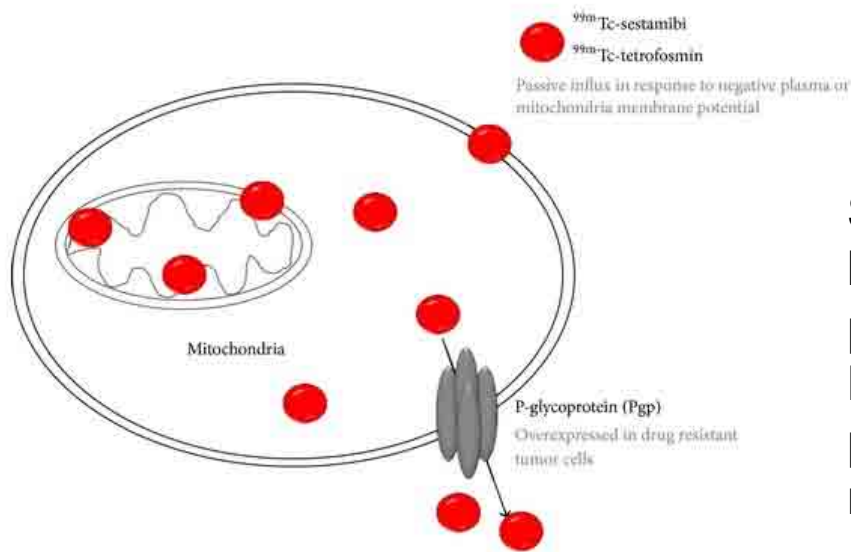


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Scintigrafia con Sesta-MIBI



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Factors related to ^{99m}Tc -sestamibi and ^{99m}Tc -tetrofosmin tumor uptake:

- Blood flow
- Tissue viability
- Vascular permeability
- Tumor necrosis
- Metabolic demand
- Mitochondrial activity of tumor cells
- Pgp and/or MRP expression

Coakley and coworkers reported on the use of ^{99m}Tc -sestamibi for parathyroid imaging in 1989, and several larger series soon followed.

Sesta-mibi (2-methoxyisobutyl-isonitrile) is a lipophilic, monovalent cationic compound that passively diffuses across the cell membrane. Because of the large negative transmembrane potential, it is primarily sequestered in the mitochondria and trapped intracellularly.

The retention of this tracer in parathyroid lesions is presumably related to the presence of **oxyphil cells** in these lesions. Oxyphil cells are rich in **mitochondria**, which are the site of intracellular MIBI sequestration



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Scintigrafia paratiroidea



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A tutt' oggi **non** si dispone di **traccianti specifici** per il tessuto paratiroideo: quelli comunemente impiegati (^{99m}Tc -2-metossi-isobutil-isonitrile) vengono captati anche dal tessuto tiroideo

Il sestaMIBI è un indicatore di cellularità e l'entità della sua captazione cellulare dipende principalmente dal numero di cellule metabolicamente attive e dal flusso ematico parenchimale

Di qui la proprietà del tracciante di concentrarsi elettivamente nella paratiroide "iperfunzionante", il cui profilo deve tuttavia essere differenziato dal parenchima tiroideo limitrofo



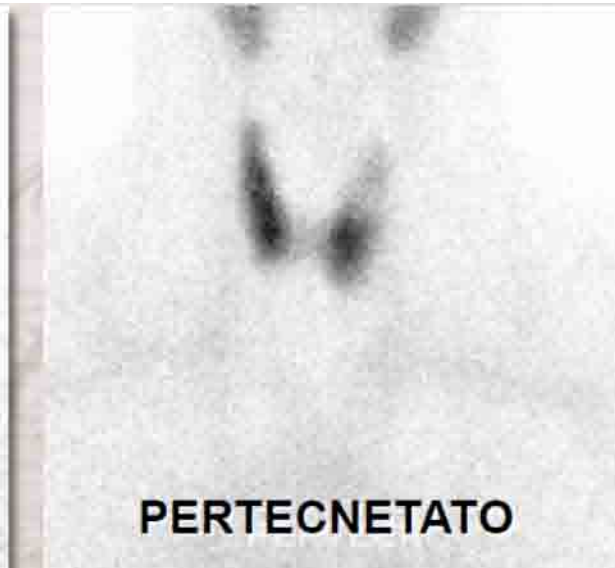
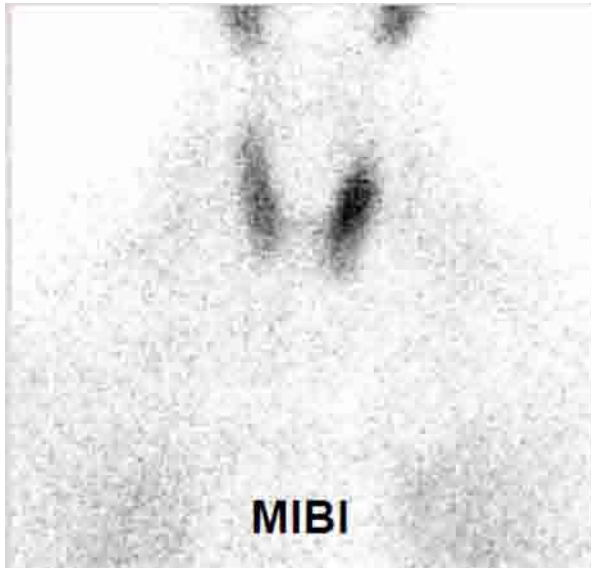
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Scintigrafia paratiroidea



ITALIAN CHAPTER

Procedura a “sottrazione di immagine con doppio tracciante” basata sul confronto delle immagini sequenziali ottenute con $^{99m}\text{TcO}_4$ (accumulo prevalente nel parenchima tiroideo), e con sesta-MIBI (che si fissano in entrambi i parenchimi).





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Scintigrafia paratiroidea



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- ✓ elevata captazione del sestamibi corrispondente ad aree di uptake del tecnezio normale o ridotta
- ✓ captazione di sestamibi in aree chiaramente clivate dal profilo tiroideo o decisamente ectopiche rispetto alla regione paratiroidea

Solo in questa seconda eventualità, la positività scintigrafia può considerarsi sufficientemente specifica.

Il tipico falso positivo è infatti rappresentato da noduli tiroidei funzionalmente autonomi (“caldi”) o da noduli tiroidei neoplastici

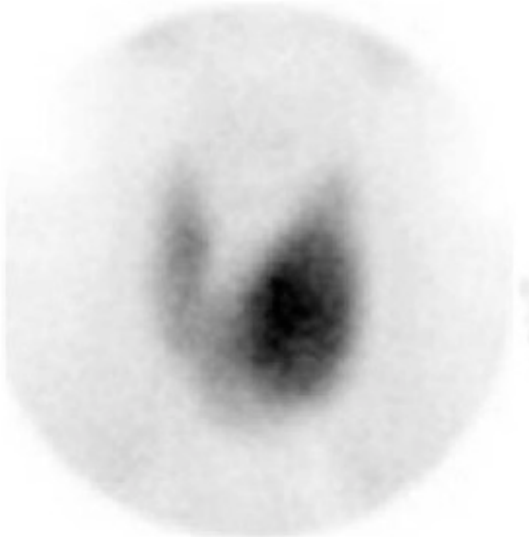


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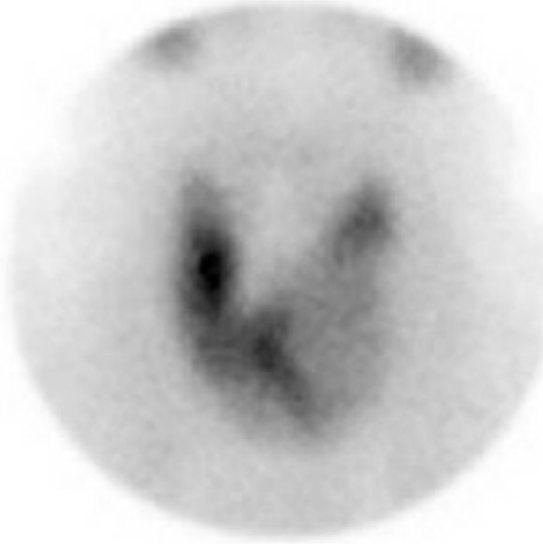
Scintigrafia paratiroidea



ITALIAN CHAPTER



mibi



tecnezio



sottrazione



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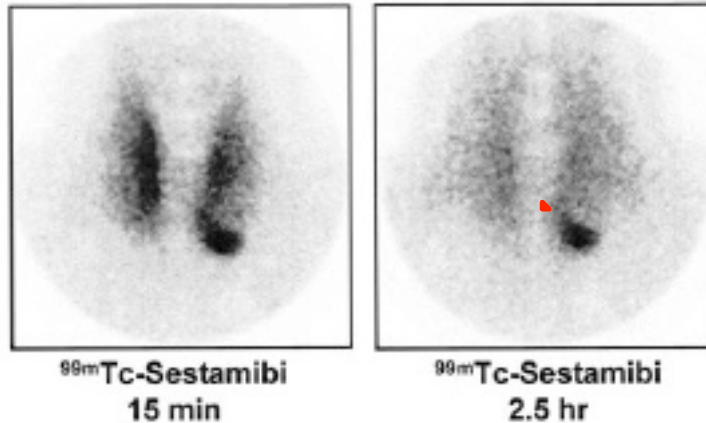
Scintigrafia paratiroidea



ITALIAN CHAPTER

Procedura a “**doppia fase**”, basata sul **più rapido wash-out** tiroideo del MIBI (5-10’) rispetto alle paratiroidi (2-3 ore)

caratterizzata da alcuni vantaggi, quali maggiore semplicità ed economicità, e la possibilità di impiego anche quadri di alterata funzionalità tiroidea.



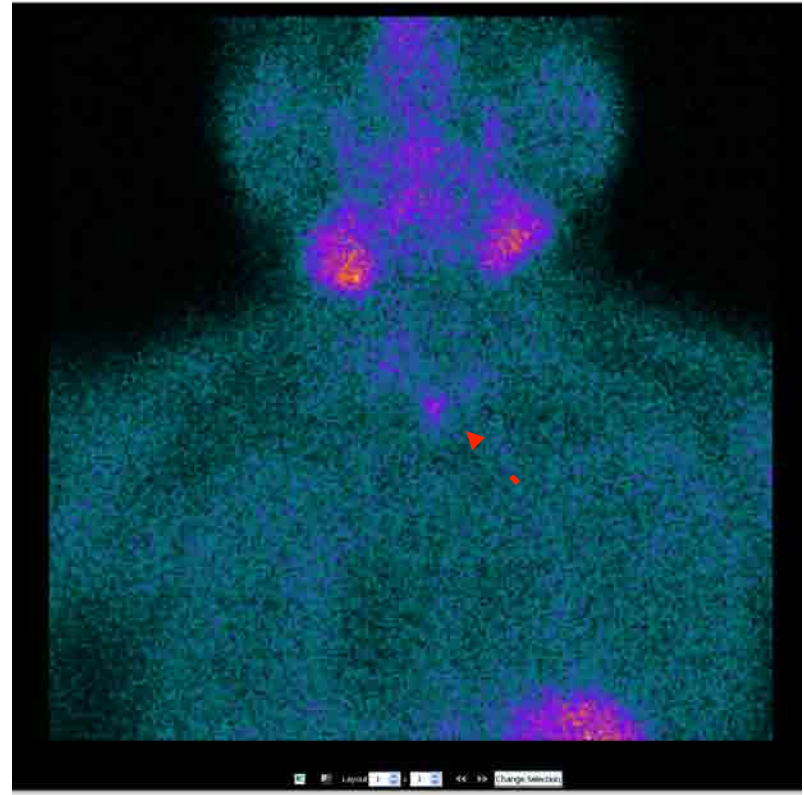
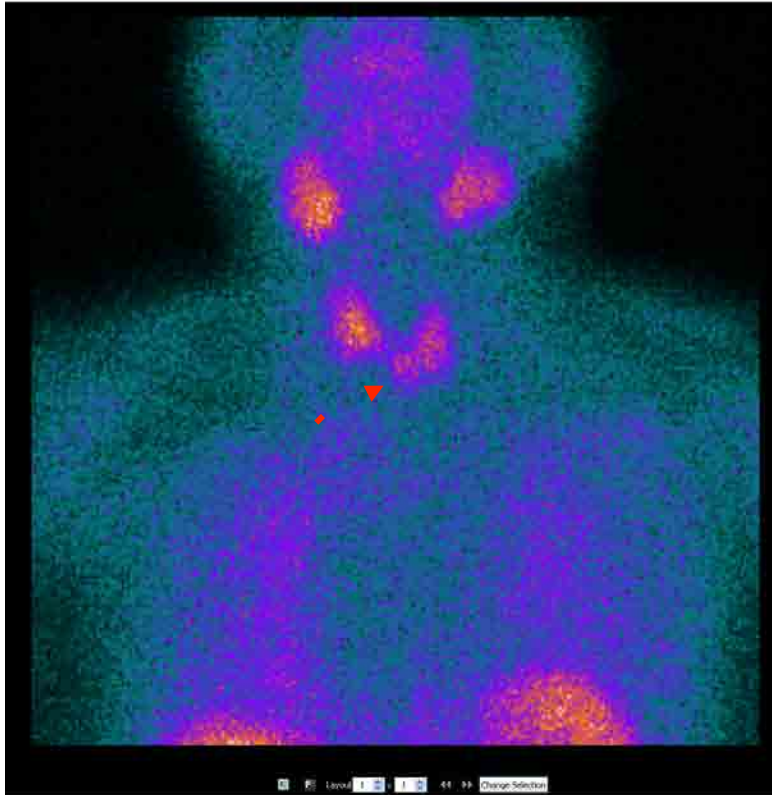


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Scintigrafia paratiroidea



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Scintigrafia paratiroidea



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L'impiego della **SPECT** aumenta la sensibilità della scintigrafia paratiroidea e soprattutto può fornire una più **accurata localizzazione topografica** della lesione mediante la ricostruzione di immagini tridimensionali.

Le tecniche di fusione TC-scintigrafia possono fornire un dettaglio anatomico superiore, di particolare utilità nel planning chirurgico.



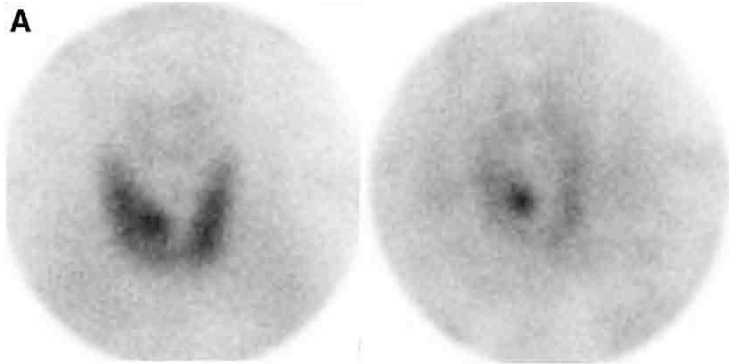
SPECT MIBI



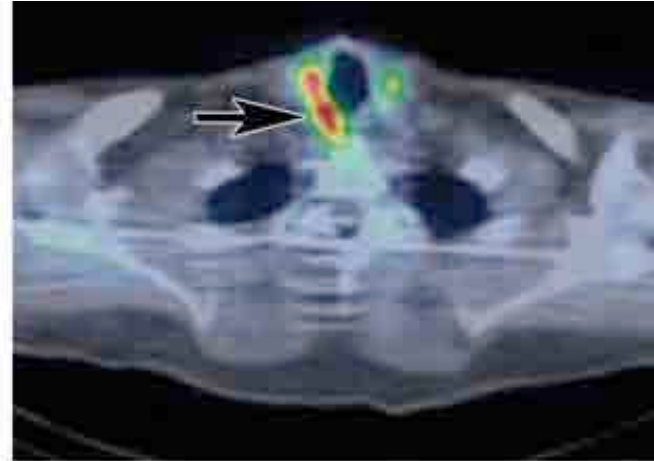
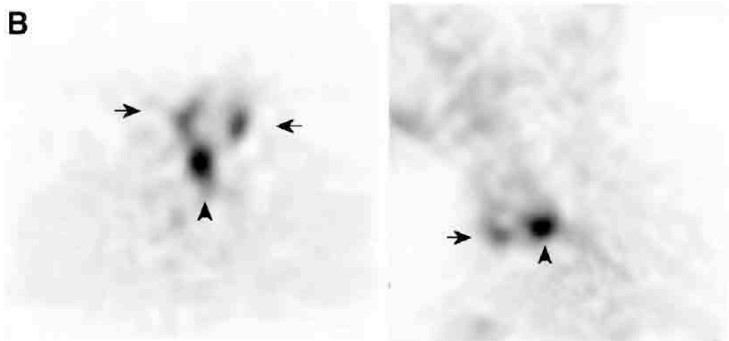
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A



B





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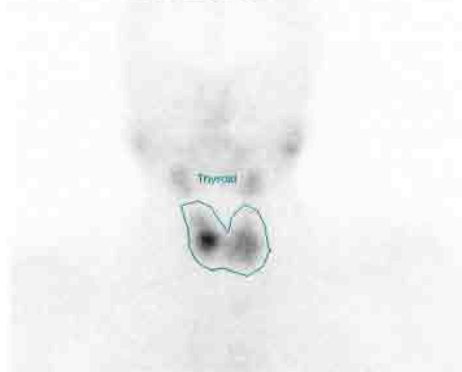
Scintigrafia paratiroidea



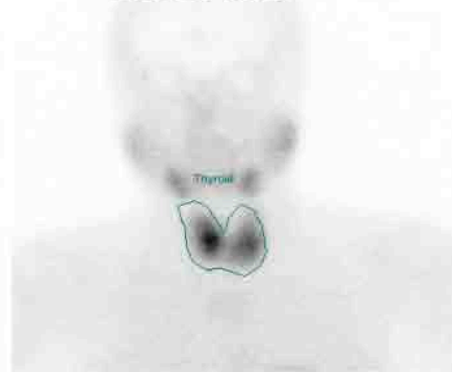
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THYROID



EARLY MIBI



SUBTRACTED



DELAYED MIBI



MIBI
12-26-19 11



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Scintigrafia paratiroidea



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- Falsi negativi
 - adenomi con rapido wash-out
 - iperplasia plurighiandolare (ridotte dimensioni)
- Falsi positivi
 - ritenzione in noduli tiroidei concomitanti (sia benigni che maligni)

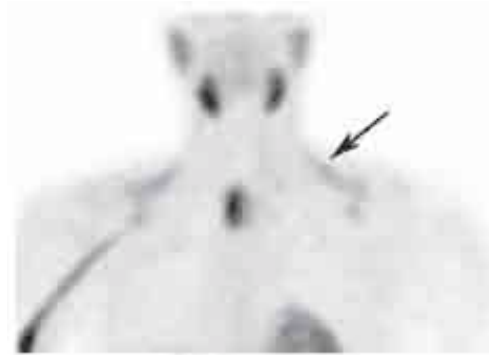


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Scintigrafia MIBI



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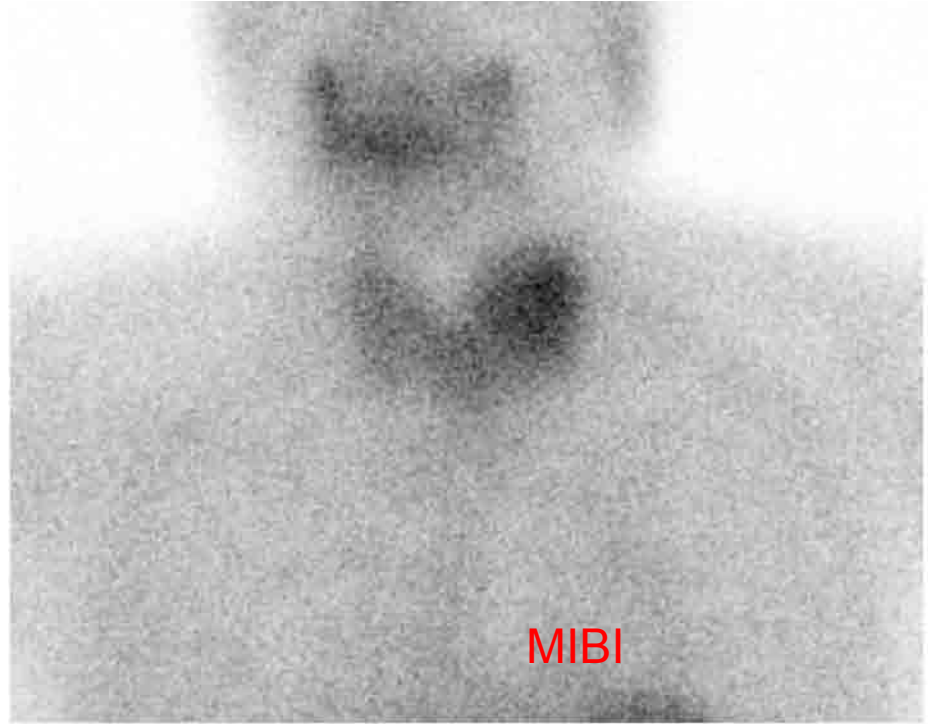


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Scintigrafia MIBI



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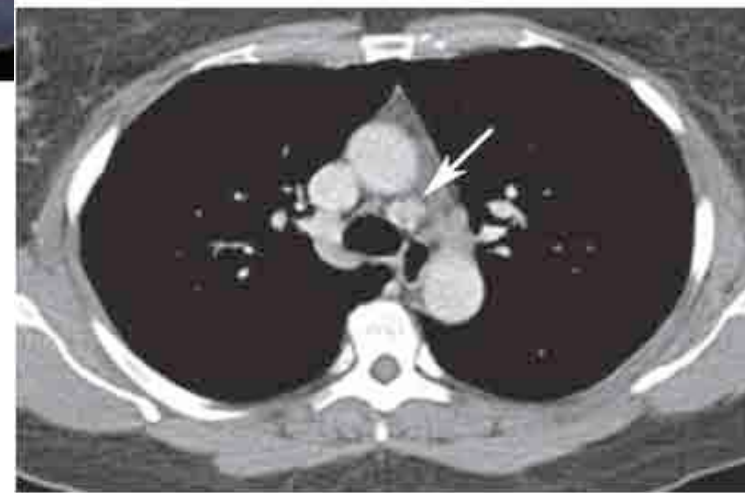
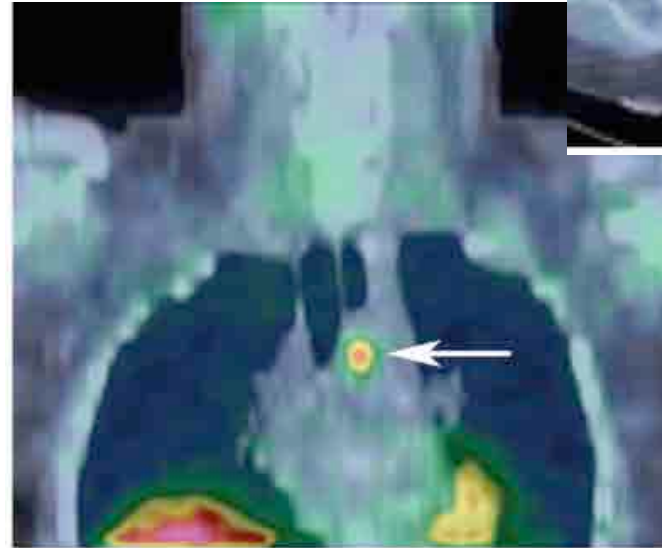


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Scintigrafia paratiroidea



ITALIAN CHAPTER





Come localizzare: strumenti



ITALIAN CHAPTER

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Imaging di II livello

TC 4D/RM

PET-TC



TC 4D paratiroidea



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- TC multifasica
 - fase basale
 - fase arteriosa eseguita dopo 45 sec. dalla somministrazione di m.d.c (*early phase*)
 - fase venosa (a 70 sec. dalla somministrazione) (*late phase*)
- Nel campo di vista: area cervico-mediastinica
 - dalla regione mandibolare a quella carenale



TC 4D



- L'adenoma paratiroideo si presenta come formazione nodulare con densità basale inferiore agli 80 HU
- più di 114 HU tra i 45 ed i 70 sec. (early phase)
- decremento della densità di circa 20 HU (late phase)

- La tiroide di base risulta più densa delle paratiroidi ed i linfonodi presentano una densità più bassa nella fase precoce che incrementa nello studio tardivo



TC paratiroidea



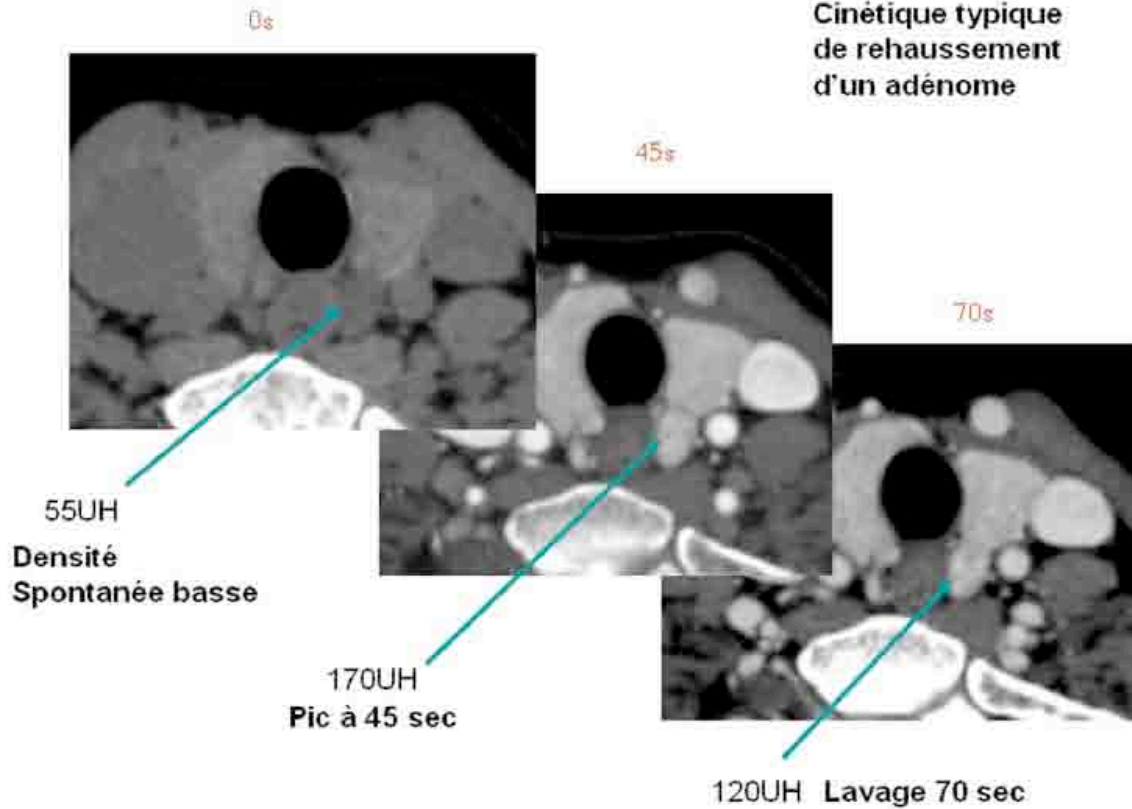
- Vantaggi
 - Ottima risoluzione spaziale → valutazione migliore nella malattia plurighiandolare
 - Possibilità di valutare i rapporti con le grosse strutture vascolari nelle ectopie mediastiniche
 - Essenziale nei casi di recidiva/persistenza di iperparatiroidismo dopo chirurgia



TC 4D

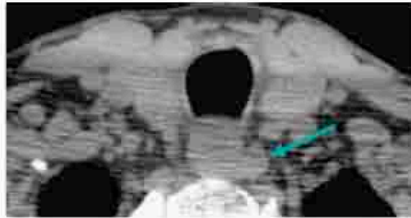


Cinétique typique
de rehaussement
d'un adénome

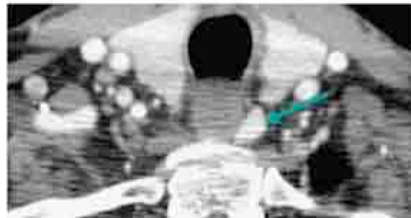




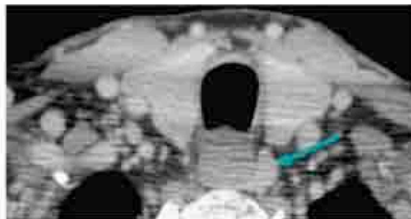
TC 4D



sans

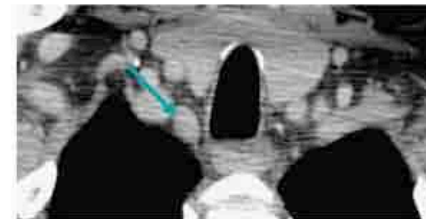
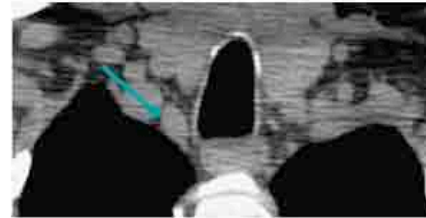


45 s



70 s

Adénome para œsophagien gauche
Forte prise de contraste
Densité à 45s > 130 UH
Lavage au temps tardif



Ganglion paratracheal droit
Prise de contraste modérée < 100 UH
lente et progressive jusqu'à 70s
Absence de lavage



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TC 4D



ITALIAN CHAPTER





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TC paratiroidea



ITALIAN CHAPTER



- Svantaggi
 - Maggior irraggiamento
 - Allergia al m.d.c. e severa IRC
 - Adenomi intratiroidici e/o a stretto contatto con la tiroide, adenomi necrotici



RM paratiroidea

- Quando non è possibile eseguire TC
- Studio dinamico multifasico (4D)
- Studio assiale e coronale in T1 e T2 prima e dopo gadolinio -> nodulo isointenso in T1 con elevato enhancement dopo m.d.c e moderatamente iperinteso in T2



RM paratiroidea



Roma, 9-12 novembre 2017

- K. Nael et al. AJNR Am J Neuroradiol 2015
- Dynamic 4D contrast-enhanced MR imaging can be used to exploit the hypervascular nature of parathyroid adenomas
 - Multiparametric MR perfusion can distinguish parathyroid adenomas from subjacent thyroid tissue or lymph nodes with diagnostic accuracies of 96%.

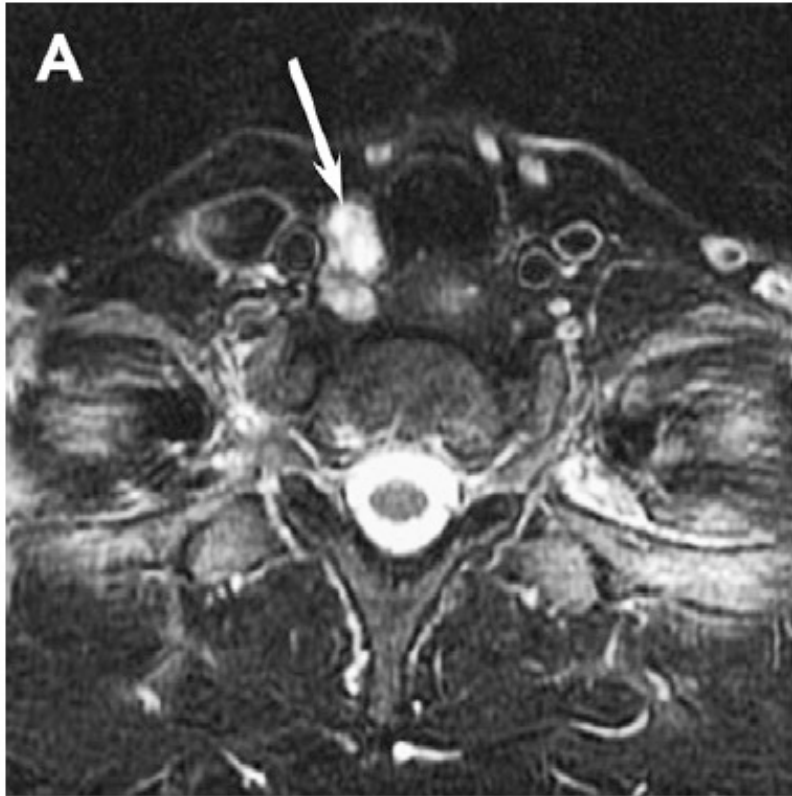


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RM paratiroidea



ITALIAN CHAPTER





Come localizzare: strumenti



ITALIAN CHAPTER

Roma, 9-12 novembre 2017

Imaging di II livello

TC 4D/RM

PET-TC



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PET paratiroidea



- La PET
 - tomografia ad emissione di positroni
 - abbinata a studio TC con miglioramento della risoluzione spaziale
 - Imaging anatomo-funzionale
- Traccianti: **11C-metionina** e **18F-colina**



PET paratiroidea



Roma, 9-12 novembre 2017

11C-methionine appears to accumulate intensively and specifically in enlarged parathyroid glands: the uptake mechanisms are not yet fully understood, although it is presumably involved in the synthesis of pre-pro-PTH, a PTH precursor

Thus, uptake of 11C-methionine could reflect amino acid influx into stimulated parathyroid tissue

Carbonio-11: emivita di 20 minuti e necessità di Cilotrone in sede

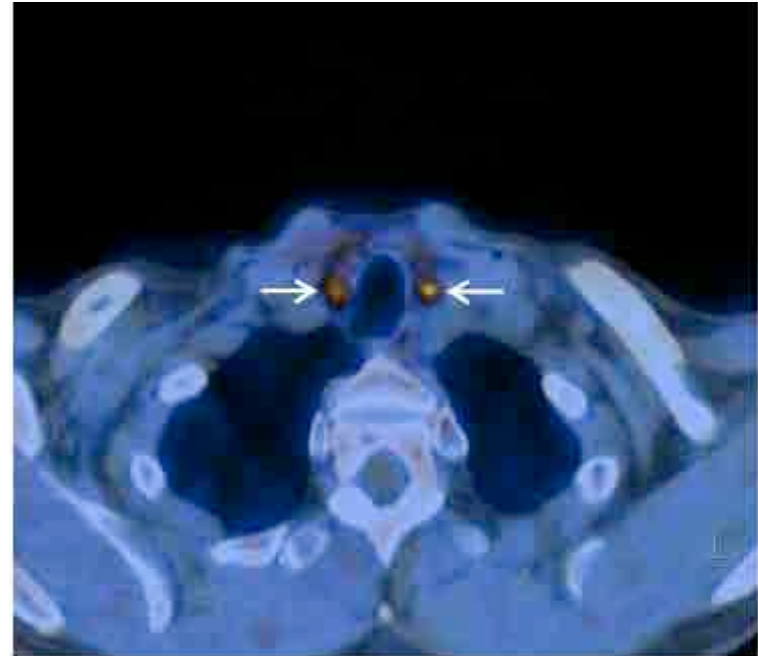
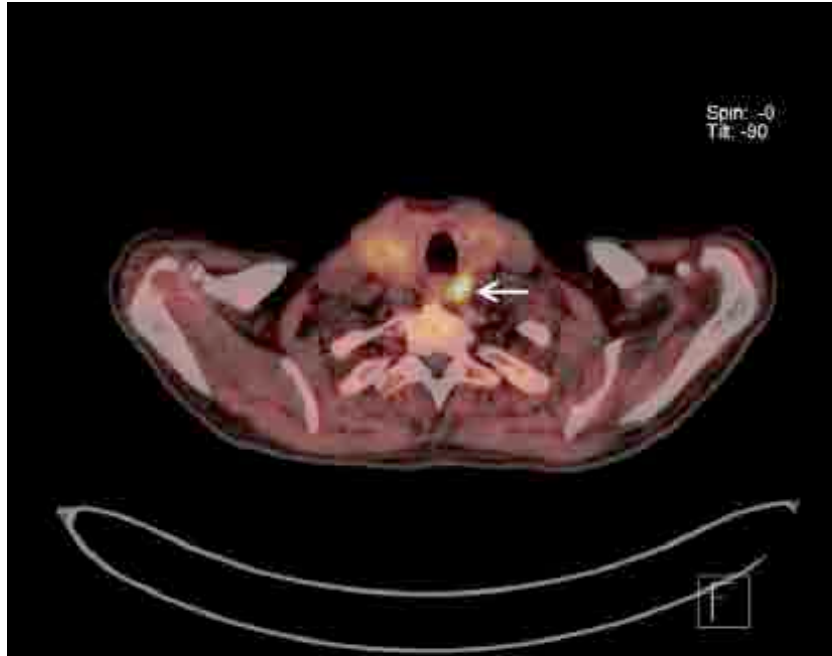


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PET-MET



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PET colina



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- ✓ La **colina** è un precursore metabolico dei fosfolipidi di membrana: nelle cellule neoplastiche si è osservato un incrementato utilizzo dei precursori fosfolipidici per l'elevata replicazione cellulare che richiede substrati strutturali per la costituzione delle membrane cellulari
- ✓ Si può legare al ^{18}F che ha un'emivita di circa 110 min
- ✓ Uso routinario nello studio dei pazienti con neoplasia prostatica
- ✓ Primi *case-report* di **incidentaloma paratiroideo** in pazienti con K prostata



Roma, 9-12 novembre 2017

PET paratiroidea

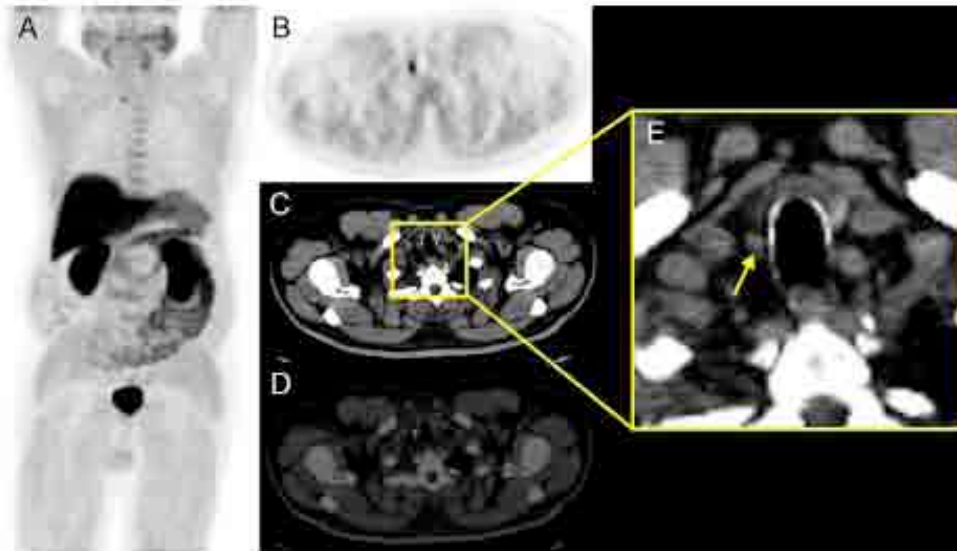


ITALIAN CHAPTER

F18-Choline, a Novel PET Tracer for Parathyroid Adenoma?

J Clin Endocrinol Metab, August 2013,

Elske Quak, Stéphanie Lheureux, Yves Reznik, Stéphane Bardet, and Nicolas Aide





PET paratiroidea



ITALIAN CHAPTER

Roma, 9-12 novembre 2017

Is ^{18}F -Fluorocholine-Positron Emission Tomography/ Computerized Tomography a New Imaging Tool for Detecting Hyperfunctioning Parathyroid Glands in Primary or Secondary Hyperparathyroidism?

Conclusion: As the main result of this pilot study, we show that in patients with hyperparathyroidism and with discordant or equivocal results on scintigraphy or on ultrasonography, adenomatous or hyperplastic parathyroid glands can be localized by FCH-PET/CT with good accuracy. Furthermore, FCH-PET/CT can solve discrepant results between preoperative ultrasonography and scintigraphy and has thus a potential as a functional imaging modality in the detection of abnormal parathyroid glands. Our preliminary results are encouraging and prompt us to further evaluate FCH-PET/CT as a functional imaging agent in patients with biochemical hyperparathyroidism. (*J Clin Endocrinol Metab* 99: 4531–4536, 2014)



PET paratiroidea



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SYSTEMATIC REVIEWS AND META-ANALYSES

Langenbeck's Arch Surg (2016)

Use of PET tracers for parathyroid localization: a systematic review and meta-analysis

Wouter P. Khijfhout^{1,2} · Jesse D. Pasternak³ · Frederick Thurston Drake¹ ·
Toni Beninato¹ · Jessica E. Gosnell¹ · Wen T. Shen¹ · Quan-Yang Duh¹ · Isabel E. Allen
Menno R. Vriens² · Bart de Keizer⁵ · Miguel H. Pampaloni⁶ · Insoo Suh¹

Conclusion

To our knowledge, this is the first systematic review investigating all PET tracers that have been used for the detection of pathological parathyroid glands. The results of our meta-analysis show that ¹¹¹C-MET PET has an overall good sensitivity and PPV and may be considered a reliable second-line imaging modality to enable minimally invasive parathyroidectomy. Our literature review suggests that ^{18F}-FCH PET may produce even greater accuracy and should be further investigated using both low-dose CT and MRI for anatomical correlation.



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PET paratiroidea



ITALIAN CHAPTER



Quando eseguirla

- Casi discordanti tra ecografia e MIBI
- Scintigrafia MIBI negativa
- Sospetto di malattia plurighiandolare

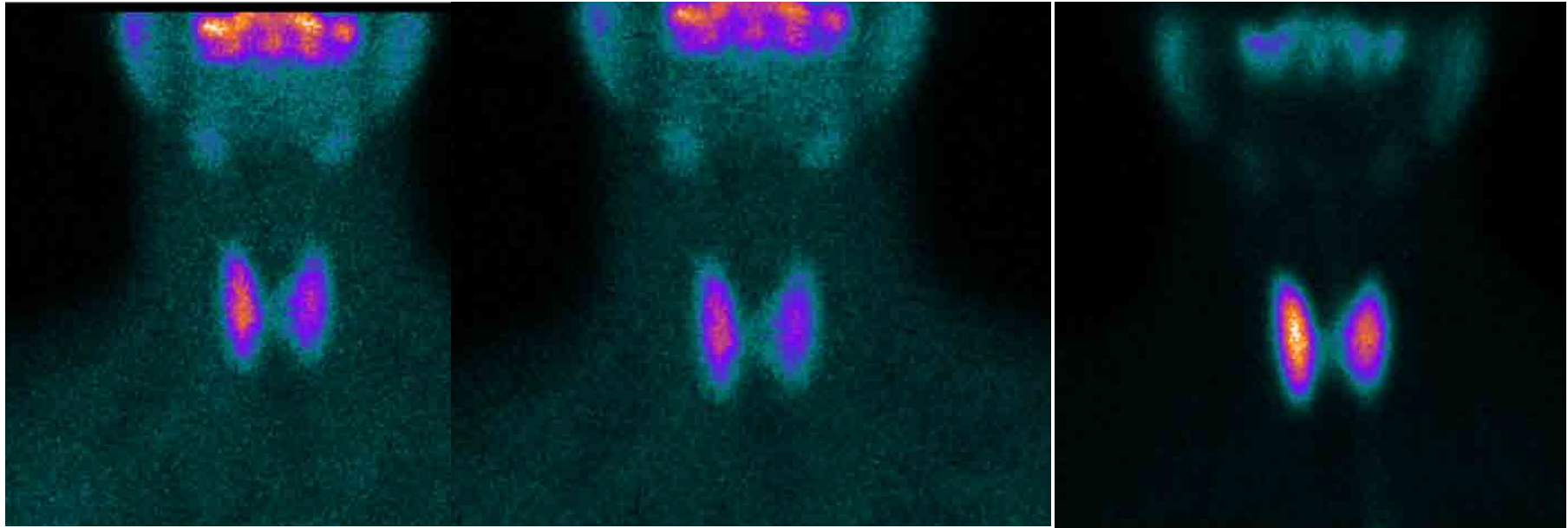


PET colina



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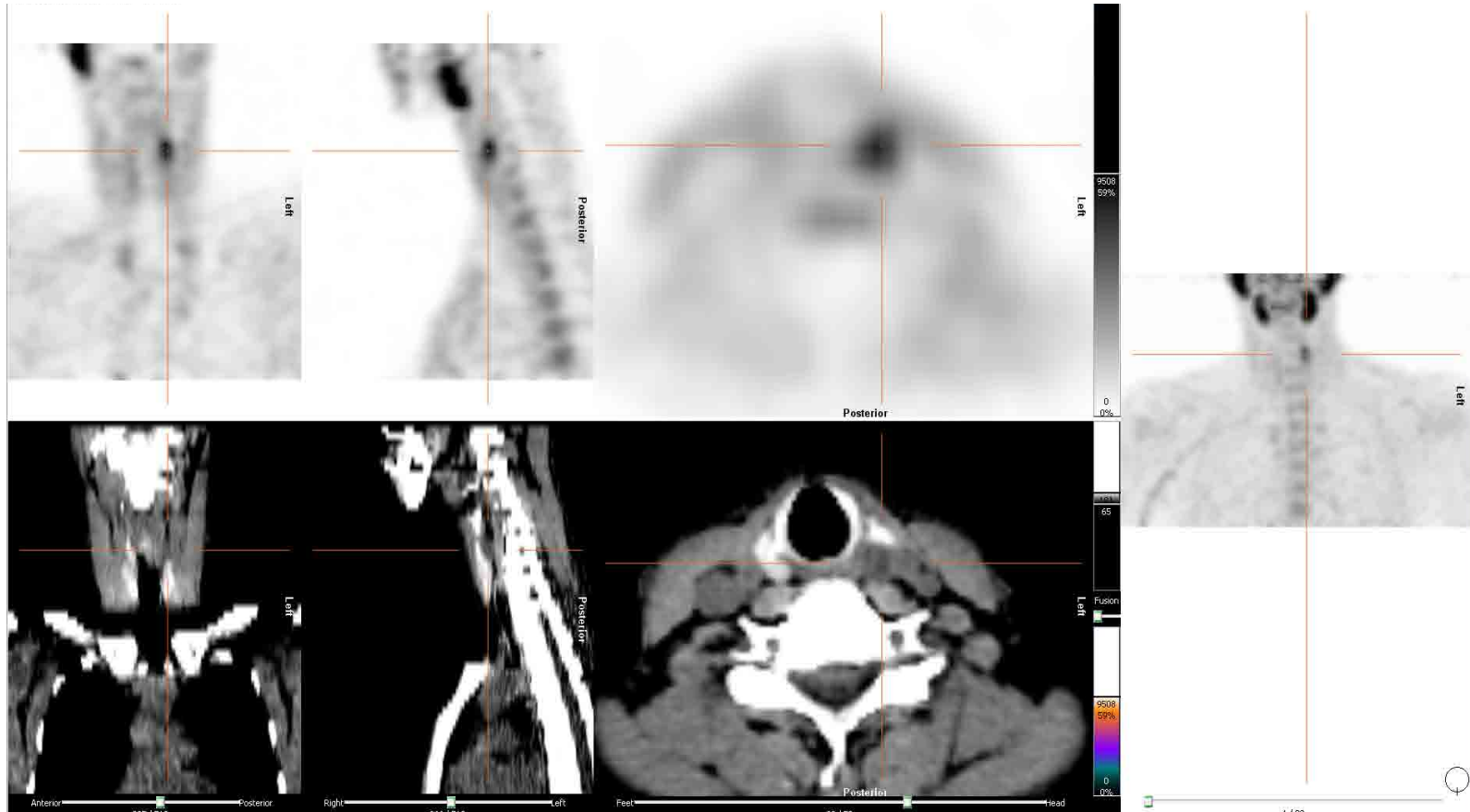


PET colina



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Roma, 9-12 novembre 2017



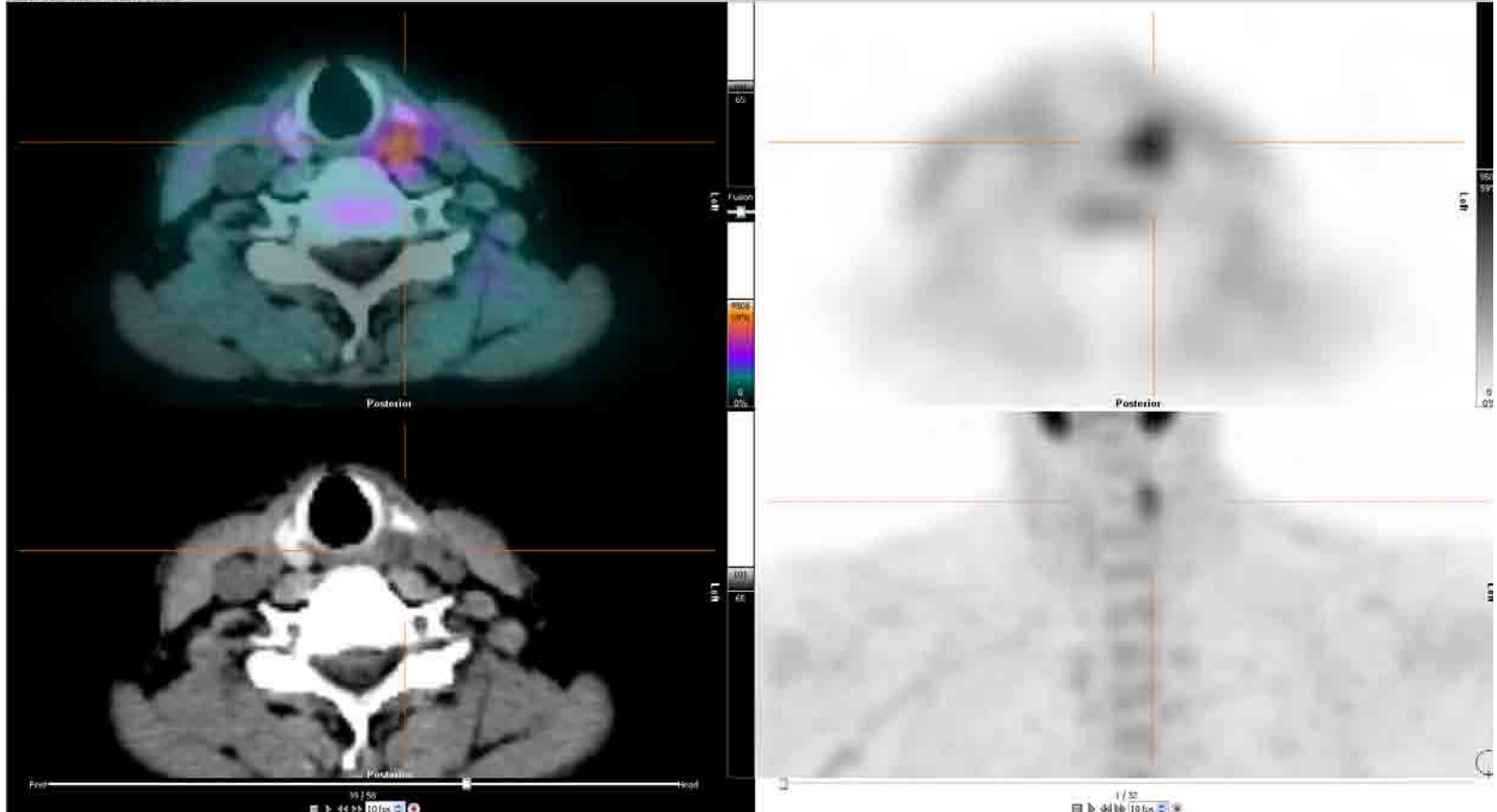


PET colina



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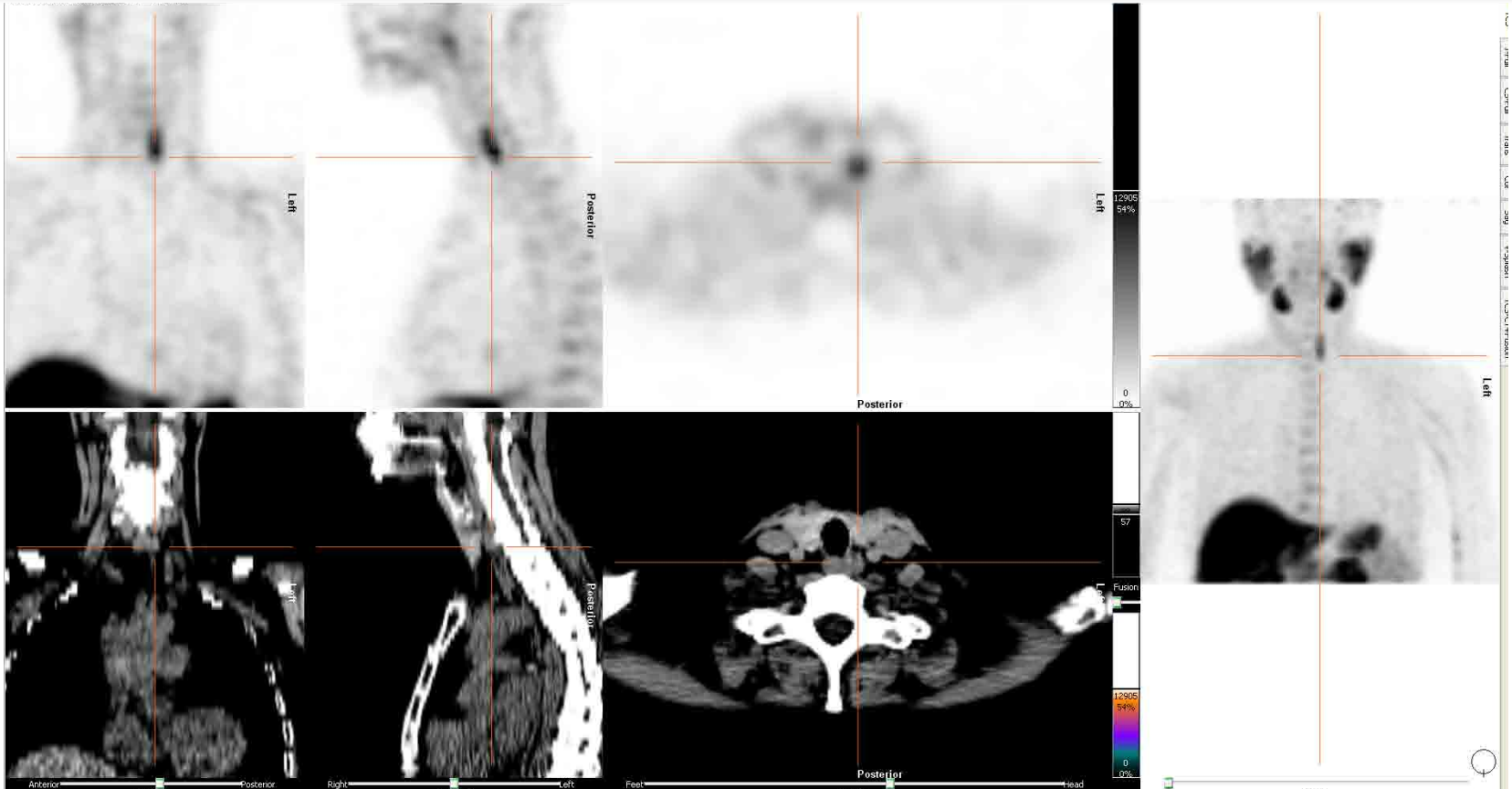


PET colina



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Take home message



Roma, 9-12 novembre 2017

CURRENT CONCEPTS IN ENDOCRINE SURGERY

Positional statement of the European Society of Endocrine Surgeons (ESES) on modern techniques in pHPT surgery

Anders O. J. Bergenfelz • Per Hellman •
Barney Harrison • Antonio Sitges-Serra •
Henning Dralle

Langenbecks Arch Surg (2009)

Parathyroid Localization and Implications for Clinical Management

John W. Kunstman, Jonathan D. Kirsch, Amit Mahajan, and Robert Udelsman

Departments of Surgery (J.W.K., R.U.) and Radiology (J.D.K., A.M.), Yale University School of Medicine, New Haven, Connecticut 06520; and Yale-New Haven Hospital (R.U.), New Haven, Connecticut 06520

J Clin Endocrinol Metab, March 2013,

JAMA Surgery | Special Communication

The American Association of Endocrine Surgeons Guidelines for Definitive Management of Primary Hyperparathyroidism

AAES Guidelines for Primary Hyperparathyroidism Management

Published online August 10, 2016

Scott M. Wilhelm, MD; Tracy S. Wang, MD, MPH; Daniel T. Ruan, MD; James A. Lee, MD; Sylvia L. Asa, MD, PhD;
Quan-Yang Duh, MD; Gerard M. Doherty, MD; Miguel F. Herrera, MD, PhD; Janice L. Pasieka, MD;
Nancy D. Perrier, MD; Shonni J. Silverberg, MD; Carmen C. Solórzano, MD; Cord Sturgeon, MD;
Mitchell E. Tublin, MD; Robert Udelsman, MD, MBA; Sally E. Carty, MD

Take home message



ITALIAN CHAPTER

REVIEW

Primary hyperparathyroidism: review and recommendations on evaluation, diagnosis, and management. A Canadian and international consensus

Osteoporos Int (2017) 28:1–19

5. Imaging.

1. Imaging is not used for the diagnosis of PHPT, which is based on biochemical profile.
2. Identification of abnormal parathyroid tissue is enhanced with single photon emission computed tomography (SPECT) study in combination with a computed tomography (CT) study and is particularly valuable in repeat surgical cases.
3. Ultrasound, ^{99m}Tc -sestamibi scintigraphy continue to be useful localization tools, however, they can miss small adenomas and hyperplasia.
4. Additional imaging or localization tools for those failing surgery or suspected of having an ectopic parathyroid gland include CT scans, MRI (Magnetic Resonance Imaging), ^{11}C -Methionine PET/CT Parathyroid Scintigraphy. Selective venous sampling should only be performed when required for remedial exploration.



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Tecniche di localizzazione



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Grazie per l'attenzione!!!!