

Case Report

SELECTIVE RADIOGUIDED PARATHYROIDECTOMY WITH INDOCYANINE GREEN PRIOR TO PREOPERATIVE ^{18}F -CHOLINE PET/CT LOCATION PARATIROIDECTOMÍA SELECTIVA RADIOGUIDA CON VERDE INDOCIANINA PREVIA LOCALIZACION PREOPERATORIA CON ^{18}F -COLINA PET/TC

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Abstract

Introduction:

Most common cause of primary hyperparathyroidism (PHPT) is parathyroid adenoma, being surgery the only curative treatment. Nowadays, minimally invasive approach is preferred instead of cervical bilateral exploration, as implies an early recovery, lower rate of complications and cost-effective results. This surgical approach requires to know exactly preoperative location of the affected parathyroid, justifying the development of more accurate imaging techniques able to precise location even in small or ectopic adenomas, multiglandular disease, persistent or recurrent PHPT.

Presentation of the case:

In the following case report, we present 83-year-old male diagnosed of PHPT during nephrologist follow-up due worsening of renal function associated with hypercalcemia 12 mg/dL and PTH 1218 pg/mL. As ^{99m}Tc -MIBI scintigraphy showed difficulties to accurately localize the infracentimetric adenoma, ^{18}F -choline PET/CT resolution allowed defining its location, suggesting the performance of a lower incision and exploration of deep planes in surgery. A selective radioguided parathyroidectomy was performed, guiding during surgery towards the pathological gland and ensuring the correct resection of the adenoma by exploring residual radioactivity of the surgical field. Intraoperative Indocyanine Green angiography also allowed to visualize the vascular pedicle. Postoperative was uneventful and follow up ensured curative results of surgery. .

Conclusion:

This case report describes the newest tools available to guarantee a minimally invasive surgical approach of the parathyroid glands, especially in those cases such as small or ectopic adenomas, multiglandular disease, persistent or recurrent PHPT where conventional tests are less sensitive. Further studies are needed to define the current place for these tools in the therapeutic algorithm of PHPT.

Keywords: Hyperparathyroidism, parathyroid adenoma, ^{18}F -Choline PET/CT, radioguided parathyroidectomy, indocyanine green, case report.

Resumen

Introducción:

La causa más frecuente de hiperparatiroidismo primario (HPTP) es el adenoma de paratiroides, cuyo tratamiento definitivo es la cirugía. La cirugía mínimamente invasiva ha reemplazado la exploración bilateral cervical, debido a su recuperación precoz, menor tasa de complicaciones y coste-efectividad. El requisito indispensable para ofrecer este abordaje es garantizar la localización intraoperatoria de la glándula patológica. Por este motivo se persigue el desarrollo de técnicas de imagen más sensibles y precisas que aseguren el diagnóstico correcto incluso en casos con adenomas pequeños o ectópicos, enfermedad multiglandular, HPT persistente o recidivado.

Presentación del caso:

Un varón de 83 años fue diagnosticado de HPTP durante el seguimiento nefrológico debido a un deterioro de la función renal asociado a una hipercalcemia de 12 mg/dL con PTH de 1218 pg/mL. Mientras la gammagrafía con ^{99m}Tc -MIBI presentó dificultades para localizar el adenoma infracentimétrico, la resolución del ^{18}F -choline PET/CT definió su ubicación, orientando la realización de una incisión inferior y exploración de planos profundos en la cirugía. Se realizó una paratiroidectomía selectiva radioguiada, ayudando durante la intervención a la identificación de la glándula patológica y garantizando la correcta resección del adenoma explorando la ausencia de radioactividad residual en el campo quirúrgico. La angiografía intraoperatoria con verde de indocianina también permitió visualizar el pedículo vascular. El paciente presentó un postoperatorio sin incidencias y sin recurrencia durante el seguimiento.

Conclusión:

El caso clínico descrito muestra las distintas herramientas disponibles para garantizar un abordaje mínimamente invasivo de las glándulas paratiroides, siendo de especial interés en aquellos casos donde las pruebas convencionales presentan menor sensibilidad, como adenomas pequeños o ectópicos, enfermedad multiglandular, y HPT persistente o recurrente. Este escenario plantea la necesidad de realizar nuevos estudios que comparen la utilidad de estas técnicas disponibles y definir su lugar en el algoritmo terapéutico actual.

Palabras clave: Hiperparatiroidismo, adenoma paratiroideo, ^{18}F -Colina PET/TC, paratiroidectomía radioguiada, verde indocianina, reporte de caso.

Introduction

The most common etiology of primary hyperparathyroidism (PHPT) is the parathyroid adenoma (80–85%), being surgery the only curative treatment. [1] The intraoperative identification can be difficult due to variable number or ectopic locations of parathyroids glands causing the surgical treatment to fail and persistence of the illness. In the last years, to improve the localization of the pathological glands, more precise diagnostic techniques have been developed making possible a selective approach instead of the classic cervical bilateral exploration and benefiting from the advantages of minimally invasive surgery. [2]

^{18}F -fluorocholine PET/CT has emerged recently as a promising imaging technique for preoperative localization of parathyroid adenomas, with superior sensitivity and precision than ultrasound or ^{99m}Tc -MIBI. It is of particular interest in detection of small or ectopic glands. [3] On the other

hand, indocyanine green (ICG) angiography has also begun to be used for intraoperative identification and determination of the viability of the parathyroid glands. [4]

In the following case report, reported in line with the SCARE 2020 criteria [5], we present a multimodal approach for the surgical treatment of PHPT using ^{18}F -choline PET/CT for preoperative localization combined with radioguided parathyroidectomy and ICG angiography for intraoperative identification of the pathological gland.

Presentation of the Case

83-year-old male allergic to penicillin, with medical history of arterial hypertension and chronic renal failure secondary to obstructive urethral stricture after transurethral resection of the prostate. During nephrologist follow-up, a worsening of the renal function was detected. Blood test analysis showed hypercalcemia of 12 mg/dL and PTH of 1218 pg/mL, diagnosing PHPT.

Cervical ultrasound was not able to identify any pathological parathyroid gland. ^{99m}Tc -MIBI scintigraphy was requested which hardly showed an infracentimetric image compatible with a left superior parathyroid adenoma. The study was completed with ^{18}F -choline PET/CT, reporting greater uptake of radiotracer in relation to an 11mm x 9mm ovoid image in the left paratracheal location, posterior to the inferior-middle pole of the left thyroid lobe, suggestive of left inferior parathyroid adenoma (Figure 1).

After patient's evaluation by the Endocrine Surgery Unit, a radioguided parathyroidectomy combined with ICG angiography was

decided to perform by a senior surgeon. A minimal invasive approach was performed, making a 3 cm left lateral cervicotomy. Prior administration of 5 mCi (185 MBq) of ^{99m}Tc -MIBI, gamma-ray detector probe and portable gammacamera oriented the identification of the left inferior adenomatous-looking parathyroid gland (Figure 2). After 30 seconds of administration of 5 ml indocyanine green bolus (2.5 mg/ml concentration, not adjusted for patient weight) through a peripheral venous access, a homogeneous uptake of the pathological gland was observed (Figure 3), being finally removed.

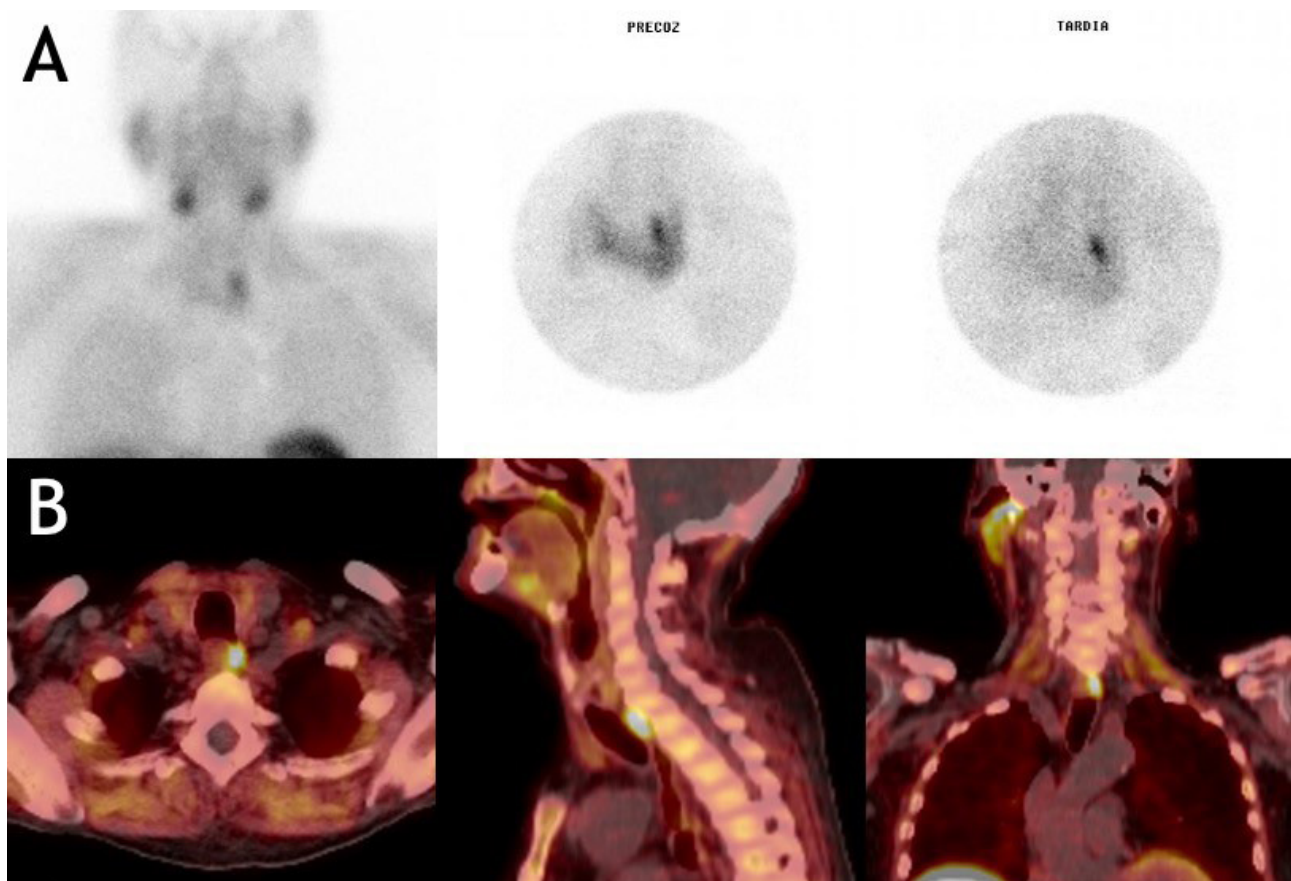


Figure 1. Comparative between scintigraphy and ^{18}F -choline PET/CT.

- a)** ^{99m}Tc -MIBI Scintigraphy (24 mCi). Focal hyper-uptake in the left upper thyroid lobe (early phase, 15'), persisting after washout of thyroid activity (late phase, 120').
- b)** ^{18}F -choline PET/CT (4.5 mCi, obtained after 60'). Ovoid image of 9x8mm with greater uptake of the radiotracer (SUV max. 9.4) is visualized in left paratracheal location, posterior to lower-middle pole of left thyroid lobe. ^{18}F -choline PET/CT has a higher resolution than scintigraphy, allowing the exact location of the adenoma and its relationship to anatomical structures.

Postoperative was uneventful and the patient was discharged home the next day with blood calcium levels of 7.9mg/dL, PTH 87 pg/mL and oral calcium supplementation. The pathological anatomy revealed a 1.4 g parathyroid adenoma. Follow up ensured curative results of surgery.

prostate cancer. A positive regulation of phospholipid-dependent choline kinases stimulated by hyperparathyroidism has been demonstrated, [6] explaining the increasing absorption of the tracer in the hyperfunctional parathyroid tissue. The diagnostic accuracy rate of this test is explained because the high-energy gamma rays from

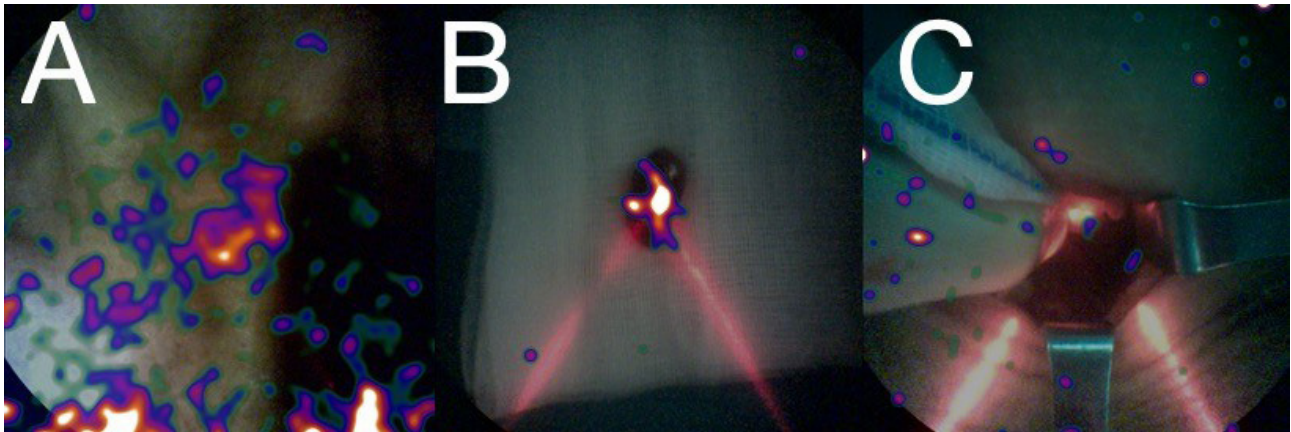


Figure 2. Photographs of portable intraoperative gamma camera.

Intraoperative scintigraphic study was performed with injection of 5 mCi of ^{99m}Tc -MIBI. Surgical intervention began 30 minutes after injection of radiotracer.

- a) Visualization of the area of greatest activity (440 cps), located in the left latero-cervical region prior to performing the selective cervicotomy.
- b) Resected adenoma (230 cps ex vivo).
- c) Absence of residual activity in the surgical field.

Discussion

This case report exemplifies the usefulness combination of three promising tools in the treatment of PHPT to ensure minimally invasive parathyroid surgery: ^{18}F -choline PET/CT for preoperative imaging localization and radioguided parathyroidectomy along with intraoperative ICG angiography. This combined approach is preferred over bilateral cervical exploration because of lower risk of complications, faster recovery, more aesthetic results, and even higher curation rates. [2]

PET/CT with ^{18}F -fluorocholine, a phospholipid analog that integrates into the recently synthesized proliferating cell membranes, was initially born as a marker in

PET images are less attenuated by the sternum and the ribs. This provides a higher spatial resolution, allowing the detection of lesions smaller than 1 cm and enables choline PET to maintain a high efficiency even in multi-glandular or ectopic lesions. [3] Moreover, the great sensitivity of ^{18}F -fluorocholine has proven that patients with a single adenoma on this test can safely undergo a focused parathyroidectomy without intraoperative PTH blood-testing [7]. Despite more studies are needed in order to assess, not only diagnostic accuracy but cost-benefit and radiation for the patient, evidence available points out ^{18}F -fluorocholine PET/CT seem to even superior to other high resolution tools such as SPECT/CT with ^{99m}Tc -MIBI as radiotracer. [3] As we have seen in this clinical case, ^{99m}Tc -

MIBI scintigraphy showed difficulties to accurately localize the infracentimetric adenoma, while the ^{18}F -choline PET/CT resolution allowed defining its location, suggesting the performance of a lower incision and exploration of deep planes in surgery. (Figure 1).

In conclusion, this case report describes the

newest tools available to guarantee a minimally invasive surgical approach of the parathyroid glands; specially in those cases such as small or ectopic adenomas, multiglandular disease, persistent or recurrent PHPT where conventional tests are less sensitive. Further studies are needed to define the current place for these tools in the therapeutic algorithm of PHPT.

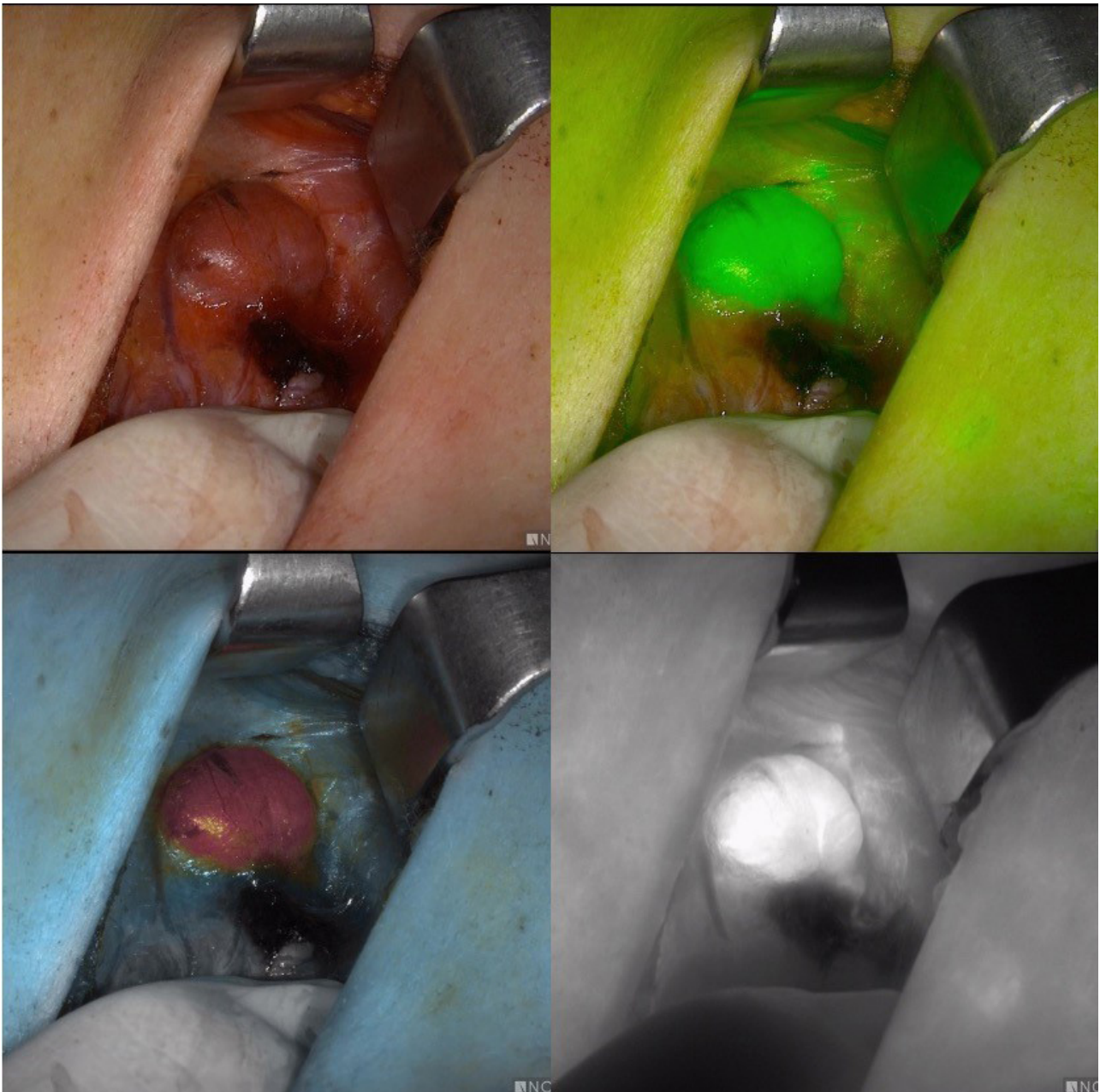


Figure 3. Indocyanine green angiography.

Intraoperative images after 30 seconds of intravenous indocyanine green bolus administration. A greater fluorescence of the adenoma can be seen in relation to the surrounding tissues. Monochromatic filter facilitates visualization of the vascular pedicle, while thermal scale filter stands out the greater fluorescence of the adenoma.

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