Intraoperative Detection of Hyperplastic Parathyroid Gland With Positron Emitter 18F-Fluorocholine and Handheld Probe

Golubić, Anja Tea; Poljak, Frano; Bumber, Boris; Huić, Dražen

Source / Izvornik: **Clinical Nuclear Medicine, 2020, 45, 636 - 637**

Journal article, Accepted version
Rad u časopisu, Završna verzija rukopisa prihvaćena za objavljivanje (postprint)

https://doi.org/10.1097/RLU.0000000000003106

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:105:480991

Intraoperative detection of hyperplastic parathyroid gland with positron emitter F-18 fluorocholine and handheld probe

ABSTRACT:

We present the first intraoperative detection of a hyperplastic parathyroid gland with a positron emitter F-18 fluorocholine and hand-held probe, with the estimation of the absorbed dose to the surgeon and surgical staff. Intraoperative positron emitter detection enabled the resection of a small parathyroid gland, resulting in normal postoperative values of PTH and serum calcium in a 69-year-old woman. Calculated whole-body dose to the surgical staff and surgeons' fingers is well below the annual limits for exposed workers and general public. Intraoperative F-18 FCH detection with hand-held probe is a safe and feasible method for localizing small parathyroid glands.

KEYWORDS: F-18 fluorocholine, dosimetry, intraoperative detection, handheld probe

REFERENCES:

1. Bilezikian JP. Primary hyperparathyroidism. J Clin Endocrinol Metab. 2018;103:3993-4004.

2. Kunstman JW, Kirsch JD, Mahajan A, et al. Clinical review: Parathyroid localization and implications for clinical management. J Clin Endocrinol Metab. 2013;98:902-912.

3. Grimaldi S, Young J, Kamenicky P, et al. Challenging pre-surgical localization of hyperfunctioning parathyroid glands in primary hyperparathyroidism: the added value of 18F-Fluorocholine PET/CT. Eur J Nucl Med Mol Imaging. 2018;45:1772-1780.

4. Zajíčková K, Zogala D, Kubinyi J. Parathyroid imaging by (18)F-fluorocholine PET/CT in patients with primary hyperparathyroidism and inconclusive conventional methods: clinico-pathological correlations. Physiol Res. 2018;67:551-557.

5. Cuderman A, Senica K, Rep S, et al. 18F-Fluorocholine PET/CT in primary hyperparathyroidism: superior diagnostic performance to conventional scintigraphic imaging for localization of hyperfunctioning parathyroid glands. J Nucl Med. 2019; https://doi: 10.2967/jnumed.119.229914.

6. Khokar AM, Kuchta KM, Moo-Young TA, et al. Increasing trend of bilateral neck exploration in primary hyperparathyroidism. Am J Surg. 2019;219:466-470.

7. Christoforides C, Vamvakidis K, Miliaras S, et al. Surgical treatment in patients with single and multiple gland primary hyperparathyroidism with the use of intraoperative parathyroid hormone monitoring: extensive single-center experience. Hormones (Athens). 2019;18:273-279.

8. DeGrado TR, Reiman RE, Price DT, et al. Pharmacokinetics and radiation dosimetry of 18F-fluorocholine. J Nucl Med. 2002;43:92-96.

9. Madsen MT, Anderson JA, Halama JR, et al. AAPM Task Group 108: PET and PET/CT shielding requirements. Med Phys. 2006;33:4-15.

FIGURE LEGEND

FIGURE 1. We report a case of a 69-year-old woman with primary hyperparathyroidism (1), with negative neck ultrasound and Tc-99m sestaMIBI scintigraphy (2). F-18 fluorocholine (FCH) positron emission tomography (PET/CT) scan (3, 4, 5), was performed as the localization of small parathyroid glands is difficult (6,7). Neck and thoracic regions were scanned 15 minutes after intravenous application of 185 MBq (5 mCi) F-18 FCH. Focal uptake was found in a small nodule, located paraesophageal right, anteriorly of Th 1 vertebra, axial dimensions 0.7x0,5 cm (Fig.1). Due to small size and location, intraoperative localization was presumed difficult and guided techniques were discussed. To ensure the patient and surgical teams' safety, dosimetry parameters F-18 were calculated and surgery was performed after 2.7 mCi F-18 FCH injection. A positive intraoperative identification of the lower right parathyroid gland was confirmed by using a hand-held probe calibrated to positron measurement, measuring up to 119 counts. The gland was resected, and a drop of counts in the operative region was noted. Pathohistological diagnosis confirmed a hyperplastic parathyroid gland, and postoperative PTH and serum calcium levels normalized. For the calculation of absorbed dose prior to surgery, initial parameters were administration of 2.7 mCi F-18 FCH to a 65 kg female with surgery starting 65 minutes after radiopharmaceutical administration and lasting for 1 hour. The estimation of the effective dose to the surgeons' fingers due to radiation from the patients' neck and a whole-body effective dose to the medical staff in the operating room were calculated. The highest uptake of F-18 FCH occurs in kidneys, liver and spleen (8). We made a conservative assumption that 10% of initial administered activity goes to the neck. Assuming radiation source as a point source and neglecting the attenuation in the neck tissue, we set the distance from the source to the surgeons' fingers to be 1 cm during surgery. Correction for the physical decay due to F-18 short half-life, a reduction factor of dose received over time (9) is calculated as $R=1.443x(T_{1/2}/t)x[1-exp(-0.693t/T_{1/2})]$ and the dose as $D=(10\%xA_txγxRxt)/r^2$ (A_t

activity at start of surgery; γ gamma constant for F-18 point source 0.143 μSv m^2/MBqh (9); R reduction factor; t exposure duration; r distance from source). Resulting estimated dose to the surgeons' fingers is 7.87 mSv. The annual dose limit for the extremities (for exposed workers) is 500 mSv. Estimation of whole-body effective dose to the medical staff was calculated correcting for physical and biological decay, assuming 10% excretion of activity through urine and patients' body absorption. The dose is calculated as $D=(90\% x A_t x \gamma_p x R x t)/r^2$ (A_t activity at start of surgery; γ_p patient gamma constant 0.092 μSv m^2/MBqh (9); R reduction factor, t exposure duration; r distance from source). Estimates for 20, 50 and 100 cm distances from the patient were calculated, resulting in 0.115, 0.0184 and 0.0046 mSv respectively. The annual whole-body dose limit is 20 mSv for exposed workers and 1 mSv for general public, the calculated surgeons' finger dose and whole-body dose to the surgical staff are well below the annual limits.