

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

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**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

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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 $R=1.443 \times (T_{1/2}/t) \times [1 - \exp(-0.693t/T_{1/2})]$ and the dose as $D=(10\% \times A_t \times \gamma \times R \times t)/r^2$ (A_t

activity at start of surgery; γ gamma constant for F-18 point source $0.143 \mu\text{Sv m}^2/\text{MBqh}$ (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 $D=(90\% \times A_t \times \gamma_p \times R \times t)/r^2$ (A_t activity at start of surgery; γ_p patient gamma constant $0.092 \mu\text{Sv m}^2/\text{MBqh}$ (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.

