Parathyroid Gland Detection in Hyperparathyroidism with [18F]fluorocholine PET/CT

W.A.M. Broos, MD, PhD
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Maastricht University

Promotor:
Prof. N.C. Schaper, MD, PhD

Co-promotors:
M. Wondergem, MD, PhD
R.J.J. Knol, MD, PhD

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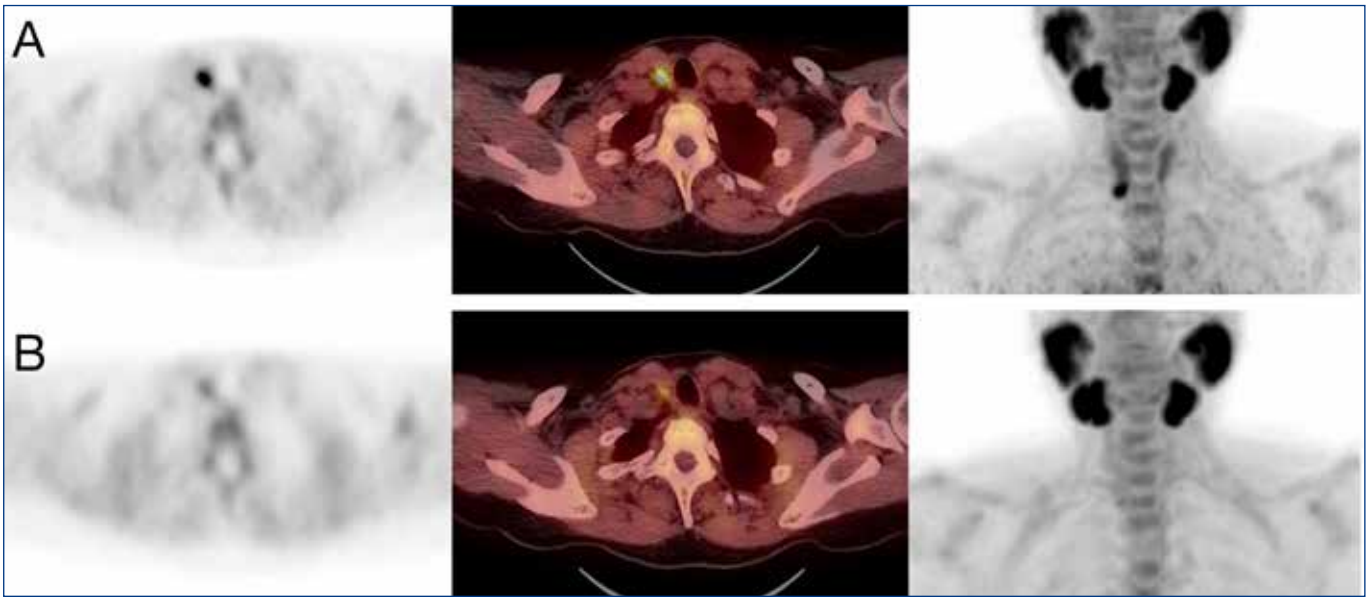
Accurate preoperative localisation of hyperfunctioning parathyroid glands is important in patients with primary hyperparathyroidism who are planned for parathyroidectomy, especially since minimally invasive surgical procedures are regularly used nowadays. An upcoming imaging technique to localise hyperfunctioning parathyroid glands is [18F]fluorocholine ([18F]FCH) PET/CT. Objectives of the thesis were to critically review the current scientific literature related to [18F]FCH PET/CT parathyroid localisation, to further specify scan acquisition protocols and to explore the clinical implications of parathyroid localisation with [18F]FCH PET/CT.

Since different scan acquisition protocols have been used throughout literature without consensus about the optimal protocol, several aspects involving scan acquisition parameters were studied. Because some hyperfunctioning parathyroid glands are known to show fast wash-out of the tracer, they can be missed on regular imaging at 60 min post-injection (p.i.) of [18F]FCH (figure 1). We studied the value of an early scan at 5 min p.i. which was compared with standard late images (60 min p.i.). In a cohort of 64 patients with histopathologically proven parathyroid adenomas or hyperplasia, 20% was better visualised at the early time point, in 6% visualisation was best at 60 min p.i. and in 2% the gland was exclusively visualised on late images. With demonstration of these different wash-out patterns, we concluded that dual-time-point images can be of added value in localising parathyroid glands.

Moreover, parathyroid detection can be complicated by [18F]FCH activity in surrounding structures such as the thyroid gland, obscuring parathyroid glands, or uptake in lymph nodes, a possible cause for false positive results. The value of dynamic imaging to distinguish parathyroid glands from other structures with [18F]FCH uptake was studied and, additionally, these data were analysed to determine the optimal scan acquisition time points. A total of 101 dynamic scans in patients with histopathologically proven parathyroid adenomas were analysed. Differentiation of a parathyroid adenoma from active lymph nodes was best in the first 5 min p.i., but could not definitively discriminate between the two structures. The optimal time point to distinguish a parathyroid adenoma from thyroid activity was after 10 min. All in all, dynamic scanning contributed to characterisation of hyperfunctioning parathyroid glands and determination of optimal scan acquisition time points.

To study [18F]FCH PET/CT as a first-line imaging modality in clinical practice, scan performance was evaluated in a large patient cohort consisting of 271 patients with primary hyperparathyroidism. In this cohort, 139 patients underwent parathyroidectomy and the calculated parathyroid gland detection rate was 90% and 96%, in a per lesion-based and a per patient-based analysis, respectively. These results were in accordance with the available scientific literature. We concluded that the use of [18F]FCH PET/CT as a first-line imaging modality is suitable in preoperative planning of parathyroid surgery.

Incidental findings are regularly detected on [18F]FCH PET/CT for parathyroid imaging, but frequency and relevance are unknown. Therefore, 388 [18F]FCH PET/CT scans were reviewed for abnormalities unrelated to the parathyroid glands and were correlated with follow-up data. Incidental findings were detected on 58% of the scans, abnormally increased [18F]FCH uptake was detected in 22% of the patients and malignant lesions were detected in 10 patients (2.6%). Especially breast cancer was a frequently detected



Figuur 1. Example of a dual-time-point [^{18}F]FCH PET/CT with superior visualisation of a parathyroid adenoma on early images. **A**. Early images (from left to right: axial AC PET, PET/CT fusion and MIP images acquired at 5 min after injection) show intense tracer uptake in a right inferior parathyroid adenoma. **B**. Late images (from left to right: axial AC PET, PET/CT fusion and MIP images at 60 min after injection) show a nearly complete washout of the tracer.

incidentaloma in this particular patient population in which women are typically over-represented.

In conclusion, the results of the studies presented in the thesis are in line with the available scientific literature on [^{18}F]FCH PET/CT parathyroid imaging and demonstrate superior performance of this imaging technique to localise hyperfunctioning parathyroid glands. Moreover, the findings contribute to optimisation of scan acquisition protocols and give a better insight into the frequency and relevance of incidental findings on [^{18}F]FCH PET/CT scans. Finally, although several aspects of this novel imaging technique should be further clarified, such as cost-effectiveness, the expectation is that in the future [^{18}F]FCH PET/CT will have a prominent role in parathyroid imaging.

w.broos@nwz.nl ♦