The Impact of a Bayesian Penalized-Likelihood Reconstruction Algorithm on a Dual-Time-Point Acquisition Protocol while Performing Ga-68-PSMA PET for Primary Prostate Cancer Detection

Tiago Sampaio Vieira1, Manuel Teixeira Gomes2, Diogo Borges Faria3, Sérgio Barroso4 and José Pereira de Oliveira1

1HPP-Medicina Molecular, Porto, Portugal; Lenitudes Medical Center and Research, Santa Maria da Feira, Portugal
2Centro Hospitalar do Porto/Hospital de Santo António, Hospital Lusíadas Porto, Porto, Portugal.
3HPP-Medicina Molecular, Porto, Portugal; Lenitudes Medical Center and Research, Santa Maria da Feira, Portugal
4School of Health Sciences, University of Aveiro, Portugal
5Lenitudes Medical Center and Research, Santa Maria da Feira, Portugal

Keywords: Dual-time-point Ga-68-PSMA PET; Bayesian penalized likelihood reconstruction algorithm; Primary detection

Abstract

A patient performed dual-time-point Ga-68-PSMA PET/CT for prostate cancer evaluation; images reconstructed using OSEM and Q.Clear™. Early and delayed PET revealed focus of increased uptake in prostate right peripheral zone, coincident with a suspicious lesion on MRI; lesion by normal prostate tissue uptake ratios increased with time. Furthermore, delayed-time-point PET revealed another smaller focus of increased uptake in prostate left peripheral zone, not shown by MRI. Some Q.Clear™ ß values determined higher uptake ratios. Biopsy confirmed two cancer lesions. Optimization of Q.Clear™ while performing dual-time-point Ga-68-PSMA PET may further improve image-guided targeted biopsy and focal therapy for primary prostate cancer.

Keywords: Dual-time-point Ga-68-PSMA PET; Bayesian penalized likelihood reconstruction algorithm; Primary detection

The Impact of a Bayesian Penalized-Likelihood Reconstruction Algorithm on a Dual-Time-Point Acquisition Protocol while Performing Ga-68-PSMA PET for Primary Prostate Cancer Detection is shown in Figures 1-3

Figure 1: Ga-68-PSMA PET/CT is successfully used for recurrent prostate cancer localization and primary staging in high-risk disease, and targeted biopsy in patients with high suspicion of prostate cancer is also an emerging clinical application [1]. PET may be combined with 3D ultrasound to direct targeted biopsy of the prostate [2]. Innovations on PET scanners and the use of a Bayesian penalized-likelihood reconstruction algorithm (BPLA) such as Q.Clear™ can deliver high-quality images, which could further improve the diagnostic accuracy of PET for prostate cancer detection. Q.Clear™ includes a penalty function, a noise suppression term, controlled by a penalization factor, ß, allowing an effective convergence, and more accurate SUV quantification in contrast to OSEM, which have to be stopped before contrast convergence to prevent excessive image noise [3-7]. We present the case of a 75 years-old male who performed Ga-68-PSMA PET/CT for prostate cancer evaluation. PET/CT was acquired on a Discovery IQ4R scanner using a dual-time-point acquisition protocol. 1 hour and 2 hours after radiopharmaceutical administration; images were reconstructed applying two methods: OSEM and Q.Clear™ with ß ranging from 100 to 1000. PET was digitally fused with multiparametric MRI. Early-time-point (ETP) PET revealed a focus of increased Ga-68-PSMA uptake in prostate right peripheral zone, coincident with the finding of a lesion having 20 mm of diameter and suspicious for cancer on MRI. The SUVmax of this lesion in ETP was higher using Q.Clear™ with ß of 100 and the ratio of the SUVmax of the lesion by the SUVmax of normal prostate tissue LNT.SUVmax was higher using Q.Clear™ with ß of 300.

Figure 2: The images of delayed-time-point (DTP) revealed a marked temporal decrease of SUVmax in normal prostate tissue, resulting in a pronouncedly greater LNT.SUVmax in the right peripheral zone lesion on DTP than on ETP. Moreover, on DTP the LNT.SUVmax of this lesion was highest when using Q.Clear™ with ß of 200. This is an interesting finding since previous research revealed that lesion detectability of lung nodules is better when lower ß values are used, which is thought to relate with lower noise levels in normal pulmonary parenchyma than in tissues of other body regions [6], and as previously referred, the uptake in the normal prostatic parenchyma of this patient decreased with time.

*Corresponding author: Tiago Sampaio Vieira, HPP-Medicina Molecular, Lenitudes Medical Center and Research, Portugal; E-mail: tiago.sampaio.vieira@gmail.com

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Figure 3: DTP PET revealed another smaller focus of increased uptake in prostate left peripheral zone, and LNT/SUVmax of this focus was higher when using β of 100. This second focus wasn’t coincident with any observable abnormality on MRI, but a biopsy confirmed the existence of two prostate cancer lesions, one in each lateral peripheral zone. In fact, Ga-68-PSMA PET/MRI proved to improve the diagnostic accuracy for primary prostate cancer [8,9], the value of DTP Ga-68-PSMA PET for the detection of primary and recurrent prostate cancer lesions has been described [10,11] and the synergistic effect of BPLA and DTP on recurrent prostate cancer detection was also shown [12]. This case suggests that the optimization of a BPLA while performing dual-time-point Ga-68-PSMA PET may further improve the capabilities of multimodality image-guided targeted-biopsy for primary prostate cancer detection and for focal therapy planning.

References