

A novel automatic approach for calculation of the specific binding ratio in [ $^{123}\text{I}$ ]FP CIT SPECT.

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## 学 位 論 文 の 要 旨

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学位論文題目	A novel automatic approach for calculation of the specific binding ratio in [I-123]FP-CIT SPECT. ([I-123]FP-CIT SPECT における特異的線条体結合の新しい自動解析法)		
<p><b>【Objectives 目的】</b></p> <p>Degeneration of nigrostriatal dopaminergic neurons is commonly evaluated by dopamine transporter imaging using [<sup>123</sup>I]ioflupane (FP-CIT) SPECT. The specific binding ratio (SBR), calculated from the striatal specific to non-specific binding of FP-CIT, is now used for an quantitative index in cases of Parkinsonian syndrome (PS) and dementia with Lewy body (DLB) as a supportive evidence of visual observation. Although several automatic or semi-automatic methods were developed including our previous study, to simplify the analysis, they may not avoid the operator-induced variability. The aim of this study was to eliminate the manual handling steps and to provide stable and reliable results in SBR calculation for multicenter studies as well as clinical patient follow-ups.</p> <p><b>【Methods 方法】</b></p> <p>In the present study, 105 patients (72 ± 10 years) suspected of PS or DLB underwent [<sup>123</sup>I]FP-CIT SPECT using a dual-head SPECT/CT scanner. Reconstruction of SPECT images used the CT attenuation correction (AC) method with or without scatter correction (ACSC and CTAC, respectively). Two-hundred patient data in our previous study for development of the semi-automatic method (<i>Ann Nucl Med</i>, 2019), were used in this study to develop and to confirm the fully automatic method, where a trapezoid volume of interest (VOI<sub>t</sub>) covering the bilateral striata was created automatically. The VOI<sub>t</sub> was determined based on the distance (<i>d</i>) of the bilateral striatal maximum counts at the center, and largest consecutive slices were selected as striatum containing brain slices. The 1052 most intense voxels, equal to the average striatal volume of 11.2 mL, were extracted from VOI<sub>t</sub> bilaterally as striatal VOI (VOI<sub>st</sub>). To calculate the non-specific radioactivity, the reference VOI (VOI<sub>ref</sub>) was determined automatically from the whole brain outside the VOI<sub>t</sub>, which was drawn manually in the occipital region in the previous version. To avoid sinuses and cerebrospinal fluid (CSF) spaces, low count voxels were excluded using several cut-off values of maximum VOI<sub>ref</sub> count. SBR values were calculated from the mean count-concentration (kBq/mL) of VOI<sub>st</sub> and VOI<sub>ref</sub>. The SBR results from the new 105 patients were compared with the semi-automatic method and the Tossici-Bolt (TB) method, commonly used in Japan.</p> <p><b>【Results 結果】</b></p> <p>The cut-off level of 75% maximum VOI<sub>ref</sub>, determined from several cut-offs applied to the 200 patient data previously studied, was selected for VOI<sub>ref</sub> setting in the fully automatic method because it showed no significant differences in SBR results from those of the previous semi-automatic method. SBR values calculated from the new method showed a good linear</p>			

correlation with the semi-automatic method in both patient groups ( $r > 0.98$ ). The area under the curve (AUC) of receiver operating characteristics (ROC) analysis showed no significant difference between the semi- and fully automatic methods for the previous 200 ( $AUC > 0.99$ ,  $p > 0.23$ ) and new 105 patient data ( $AUC > 0.95$ ,  $P > 0.35$ ). The AUCs of our methods were significantly greater than the SBRs from the TB method for both ACSC and CTAC images ( $AUC > 0.91$ ,  $P < 0.05$ ). The new method showed similar diagnostic accuracy to our semi-automatic method ( $> 92\%$ ) for PS/DLB diagnosis, but better than the TB method (88.3%). The new automatic method calculated SBR very quickly as fast as the mean calculation time of  $9 \pm 1$  sec including time for data saving and presentation of results.

#### 【Discussion 考察】

We proposed a fully automatic method for SBR calculation of [ $^{123}\text{I}$ ]FP-CIT SPECT in the present study to improve reproducibility without operator-induced variability. Reproducibility of the new method with two sets of patient data was identical to the previous semi-automatic method in diagnostic accuracy based on the ROC analysis. An ideal method for quantitative image analysis in clinical follow-up and multicenter studies should have high accuracy, reproducibility, as well as usability. Appropriate ROI selection is the most important factor for acquiring accurate results. To obtain fully objective results, the new method calculated the SBR values automatically by creating  $\text{VOI}_t$  appropriately to determine  $\text{VOI}_{st}$  and  $\text{VOI}_{ref}$  after excluding the voxels of the CSF space and the sinuses. Elimination of manual handling steps realized excellent reproducibility with very short handling time as fast as  $9 \pm 1$  sec compared with 2–3 min/image for the semi-automatic method, although it depends on the power of CPU. The proposed method simplified SBR calculation without application of any template or any other manual handling steps, providing excellent diagnostic accuracy and reproducibility.

#### 【Conclusion 結論】

The new fully automatic method successfully removed operator-induced variability and improved reproducibility in SBR calculation, providing accurate and highly objective results with a short calculation time.

#### [References]

Rahman MGM, Islam MM, Tsujikawa T, Kiyono Y, Okazawa H. Count-based method for specific binding ratio calculation in [I-123]FP-CIT SPECT analysis. *Ann Nucl Med*, 2019; 33: 14-21.

備考 1 ※印の欄は、記入しないこと。

2 学位論文の要旨は、和文により研究の目的、方法、結果、考察、結論等の順に記載し、2,000 字程度にまとめタイプ等で印字すること。

3 図表は、挿入しないこと。