Chapter 4

Performance evaluation of a semi-automated method for \textsuperscript{18}F-fluorodeoxyglucose uptake in abdominal visceral adipose tissue


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Submitted
ABSTRACT

Purpose: Severity of abdominal obesity and possibly levels of metabolic activity of abdominal visceral adipose tissue (VAT) are associated with an increased risk for cardiovascular disease (CVD). In this context, the purpose of the current study was to evaluate the reproducibility and repeatability of a semi-automated method for assessment of the metabolic activity of VAT using $^{18}$F-fluorodeoxyglucose ($^{18}$F-FDG) PET/CT.

Methods: Ten patients with lung cancer who underwent two baseline whole body $^{18}$F-FDG PET/LDCT scans within one week were included. Abdominal VAT was automatically segmented using CT between levels L1-L5. The initial CT based segmentation was further optimized using PET data with a SUV threshold approach (range 1.0-2.5) and a morphological erosion (range 0-5 pixels). The $^{18}$F-FDG uptake in SUV, that was measured by the automated method was compared with manual analysis. The reproducibility and repeatability were quantified using intraclass correlation coefficients (ICCs).

Results: The metabolic assessment of VAT on $^{18}$F-FDG PET/LDCT scans expressed as SUV$_{mean}$ using an automated method showed high inter and intra observer (all ICCs>0.99) and overall repeatability (ICC=0.98). The manual method showed reproducible inter observer (all ICCs>0.92), but less intra observer (ICC=0.57) and less overall repeatability (ICC=0.78) compared with the automated method.

Conclusion: Our proposed semi-automated method provided reproducible and repeatable quantitative analysis of $^{18}$F-FDG uptake in VAT. We expect this method to aid future research regarding the role of VAT in development of CVD.
INTRODUCTION

Worldwide, the prevalence of overweight and obesity is on the rise, with more than 1.9 billion adults affected today. Abdominal obesity is a major risk factor for cardiovascular disease (CVD) development and premature mortality. However, not all obese individuals are at high risk of CVD. Abdominal adipose tissue can be divided in visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT). Interestingly, VAT is related to an increased CVD risk, while SAT is not. VAT does not only provide storage of lipids but also functions as an endocrine organ with adipocytes secreting bioactive factors and pro-atherogenic cytokines (adipokines). Consequently, measurement of VAT volume improves accuracy of CVD risk profiling. However, the link between abdominal obesity and CVD may also be influenced by metabolic activity of VAT in the individual patient, with inflammation caused by overproduction of adipokines. Therefore it is likely that not only VAT volume but also the metabolic activity of VAT is linked to CVD risk.

Imaging modalities such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) are both reliable methods for the assessment of abdominal adipose tissue volume although both modalities are limited for the assessment of metabolic activity. Previous studies have assessed the metabolic activity of abdominal adipose tissue with 18F-fluorodeoxyglucose (18F-FDG) positron emission tomography (PET). Overall, there is a growing interest in quantifying VAT as a CV risk marker and as a readout for therapeutic approaches. The most common method to measure metabolic VAT activity is by manually drawing regions of interest (ROIs). However, the SUV mean in VAT measured by ROIs in different studies ranges from 0.22 to 0.88 indicating a great variability with this manual method. Consequently, there is a considerable need for a robust (semi)automated method with good accuracy an repeatability for assessment of VAT 18F-FDG uptake on 18F-FDG-PET/CT scans. The objective of this study is to evaluate the reproducibility and repeatability of a semi-automated method for assessment VAT 18F-FDG uptake using a 18F-FDG-PET/CT scan and compare its performance with commonly applied manual methods.

PATIENTS AND METHODS

To assess the reproducibility and repeatability of the automated method, test-retest scans obtained from an existing study in patients with non-small cell lung cancer were used. This study was approved by the institutional review board and was registered in the Dutch trial register (trialregister.nl, NTR3508). All procedures performed in this study were in accordance with the Ethical Standards of the institutional research committee and carried out according to the principles of the Declaration of Helsinki. Written informed consent for all subjects was obtained before study enrolment.
Patients
Per patient, two whole body $^{18}$F-FDG PET/low dose (LD) CT scans at 60 minutes uptake time were performed within one week. There were no significant differences in patient preparation and PET acquisition between the test and retest scan. In the current study, only scans obtained 60 minutes after $^{18}$F-FDG injection were included as is recommended by the European Association of Nuclear Medicine (EANM). In addition, the reproducibility and repeatability of VAT $^{18}$F-FDG uptake measurements was analysed in 10 patients (60% men, median weight 75 kilogram (IQR, 67-77), median BMI 24.6 (IQR 23.1-26.9)).

PET imaging
All PET scans were performed on a Gemini TF PET/CT scanner (Philips Healthcare, Best, Netherlands). The PET acquisition procedures and reconstruction were conform the EANM recommendations. Patients underwent a low dose (LD)CT during tidal breathing for attenuation correction purposes, followed by a whole-body $^{18}$F-FDG PET/CT scan (skull vertex to mid-thigh) 60 minutes after $^{18}$F-FDG injection, using 2 min per bed position. Weight, height, plasma glucose levels, total injected activity, time of injection, residual activity, and scan start times were recorded.

Data analysis
All measurements were performed using MATLAB software (version R2015b, The MathWorks, Inc, Natick, MA, USA). PET and LDCT data were loaded into MATLAB and PET data were realigned to match the LDCT. The quality of the image fusion was visually verified and approved for all data sets prior to the fat segmentation and analysis. In order to analyze the entire abdomen, all slices from vertebral levels L1 to L5 were manually selected. Two observers (SdB and MR) independently analyzed all PET/LDCT scans twice at different time points in order to test both inter and intra observer variability.

Adipose tissue was initially segmented by thresholding the CT images between -174 and -24 Hounsfields Units (HU). The abdominal muscular layer was used as a boundary to separate VAT and SAT. Because the abdominal muscular layer did not always totally separate the VAT and SAT on the LDCT, for instance at the linea alba, a line was manually drawn as a reference in all slices in order to separate VAT and SAT.

The metabolic activity was expressed as SUV of $^{18}$F-FDG. High SUV inside VAT and SAT can be due to overspill of metabolic active organs such as kidneys and intestines. Therefore, the initial CT based segmentation was further adapted using an SUV threshold and a morphological erosion in order to exclude spillover of signal from $^{18}$F-FDG avid structures. Because in previously studies, $SUV_{\text{mean}}$ in VAT ranged from 0.22 to 0.89 and $SUV_{\text{max}}$ from 0.53 to 1.21, the effect of using SUV thresholds ranging from 1.0 to 2.5 on VAT and SAT uptake assessments were analyzed. In addition, the effects of different erosions ranging from 0 to 5 pixels (pixel size of 1.17x1.17 mm$^2$) on VAT and SAT uptake assessments were
analyzed. The mean and median SUV generated with the automated method are referred to as $A_{\text{SUV}}_{\text{mean}}$ and $A_{\text{SUV}}_{\text{median}}$. The $A_{\text{SUV}}_{\text{mean}}$ in VAT and SAT were compared with SUV$_{\text{mean}}$ assessed with a manual ROI selection. ROIs were manually placed on 4 slices. On each of these slices, 3 circular ROIs (diameter 10.5 mm) were positioned in the VAT and 3 ROIs were positioned in the SAT. ROIs were carefully placed in regions to prevent spillover of $^{18}$F-FDG signal from surrounding organs. SUV$_{\text{mean}}$ across these slices were averaged and referred to as $A_{\text{SUV}}_{\text{mean}}$. Furthermore, the percentage of VAT volume depicted with CT that remained after thresholding and erosion was calculated. A schematic overview of the semi-automated method is shown in Figure 1.

Figure 1 | Schematic overview of the most important steps of adipose tissue segmentation on CT and SUV analysis on $^{18}$F-FDG PET/LDCT scan.

SAT=subcutaneous adipose tissue; SUV=standardized uptake values; VAT=visceral adipose tissue

Criteria optimal settings for automated metabolic assessment of VAT

The optimal threshold and erosion settings for the automated metabolic assessment of VAT had to fulfill the following criteria: (1) highly reproducible and repeatable (ICC>0.80), (2) the VAT volume that remains for analysis should be as large as possible (at least 50% of the CT based segmented VAT) while ruling out spillover effects by visual inspection, (3) The change in $A_{\text{SUV}}_{\text{median}} / A_{\text{SUV}}_{\text{mean}}$ VAT should be smaller than 0.01 which was not considered as a relevant difference.

Statistical analysis

All analyses were performed using SPSS (Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp). For reproducibility analysis only the measurements of the first (test) $^{18}$F-FDG-PET/LDCT scan performed were used as the second (retest) scan is related with the first scan and can therefore not been used as an independent measurement. For the repeatability analysis (test-retest) measurements of the same observer were used to exclude the intra-observer variability.
The influence of threshold and erosion on $^{18}\text{SUV}_{\text{mean}}$ VAT was evaluated using a generalized estimating equations approach with an unstructured covariance matrix. $^{18}\text{SUV}_{\text{mean}}$ VAT was used as the dependent variable in the model, erosion and threshold were used as factors. An interaction between erosion and threshold was also added in the model. Effects were evaluated and compared with appropriate correction for pairwise comparisons. Effect of threshold and erosion on $^{18}\text{SUV}_{\text{median}}$ VAT were analysed similarly as $^{18}\text{SUV}_{\text{mean}}$ VAT.

The automated measurement of metabolic activity (with the most optimal threshold and erosion settings) were compared to manually placed ROIs with a Wilcoxon signed-rank test. To explore whether the automated and manually measurement were correlated a Spearman correlation coefficient ($\rho$) was calculated.

The reproducibility inter and intra observers and the repeatability were quantified using intraclass correlation coefficients (ICCs; based on absolute agreement). Bland-Altman plots were used to evaluate the reproducibility and repeatability. The measurement error for the reproducibility and repeatability were calculated according to the formula of Bland and Altman. The variation coefficients (%) were calculated as the measurement error divided by the mean of the measurements.

**RESULTS**

**Semi-automated metabolic assessment of VAT threshold and erosion**

For every combination of threshold and erosion the reproducibility (inter and intra observers) and repeatability for the $^{18}\text{SUV}_{\text{mean}}$ VAT and $^{18}\text{SUV}_{\text{median}}$ VAT are calculated. As a result of 16 thresholds and 6 sizes of erosion, each 3D plot represents 96 ICCs (Supplemental Figure 1). Since the ICCs for $^{18}\text{SUV}_{\text{mean}}$ VAT and $^{18}\text{SUV}_{\text{median}}$ VAT were highly reproducible and repeatable for all combinations of threshold and erosion, both parameters could be used to report $^{18}$F-FDG uptake (see also Supplemental Figure 2).

The influence of the threshold and erosion on $^{18}\text{SUV}_{\text{mean}}$, $^{18}\text{SUV}_{\text{median}}$ VAT and percentage VAT volume remaining after threshold and erosion are shown in Figure 2. $^{18}\text{SUV}_{\text{mean}}$ VAT and $^{18}\text{SUV}_{\text{median}}$ VAT decreased significantly for every increase in erosion (all $P<0.001$) and increased significantly for every 0.1 SUV increase in threshold (all $P<0.001$). According to the earlier described criteria in this article (patients and methods), a SUV threshold of 1.9 and an erosion of 1 turned out to be the optimal setting for automated assessment of $^{18}\text{SUV}_{\text{mean}}$ VAT and as such was used for further analysis. For $^{18}\text{SUV}_{\text{median}}$ VAT a SUV threshold of $\geq 1.5$ with an erosion of 1 turned out to be optimal.
Automated Fat Analysis

Reproducibility and repeatability PET/CT data

The characteristics of the PET/CT data for observer 1 and 2 are shown in Table 1. The reproducibility inter and intra observers ICCs and the repeatability ICCs are shown in Table 2. The automated assessment of $^{\pm}SU_{\text{mean}}$ VAT in VAT and SAT were significantly higher compared to manual ROIs (both $P<0.01$). The $^{\pm}SU_{\text{mean}}$ VAT was correlated with $^{\pm}SU_{\text{mean}}$ VAT ($R=0.71$, $P=0.02$). The $^{\pm}SU_{\text{mean}}$ SAT was correlated with $^{\pm}SU_{\text{mean}}$ SAT ($R=0.79$, $P<0.01$).

Figure 3 shows the intra observers reproducibility for $^{\pm}SU_{\text{mean}}$ VAT and $^{\pm}SU_{\text{mean}}$ VAT and corresponding Bland-Altman plots. In addition, the intra observers mean $^{\pm}SU_{\text{mean}}$ VAT was 0.48, with a measurement error of 0.091 SUV and variation coefficient of 19.2%. The mean $^{\pm}SU_{\text{mean}}$ VAT was 0.73 with a measurement error of 0.004 SUV and variation coefficient of 0.6%.

Figure 4 shows the repeatability, test-retest data, for $^{\pm}SU_{\text{mean}}$ VAT and $^{\pm}SU_{\text{mean}}$ VAT and corresponding Bland-Altman plots. The mean $^{\pm}SU_{\text{mean}}$ VAT was 0.55 with a measurement error of 0.069 SUV and variation coefficient of 12.6%. The mean $^{\pm}SU_{\text{mean}}$ VAT was 0.73 with a measurement error of 0.019 SUV and variation coefficient of 2.5%.

Figure 2 | The influence of threshold and erosion on $^{\pm}SU_{\text{mean}}$ VAT (A), $^{\pm}SU_{\text{median}}$ VAT (B) and the percentage of VAT volume for metabolic analysis (C).
Table 1 | PET/CT data characteristics for both observers.

<table>
<thead>
<tr>
<th>PET/CT data characteristics</th>
<th>Observer 1</th>
<th>Observer 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance L1-L5 (cm)</td>
<td>15.8 (15.0-16.1)</td>
<td>15.5 (15.0-16.5)</td>
</tr>
<tr>
<td>VAT volume (cm³)</td>
<td>2406 (1711-3869)</td>
<td>2344 (1646-3921)</td>
</tr>
<tr>
<td>SAT volume (cm³)</td>
<td>1986 (1700-3049)</td>
<td>2056 (1724-3135)</td>
</tr>
<tr>
<td>$^{6}$SUV$_{mean}$ VAT</td>
<td>0.49 (0.44-0.59)</td>
<td>0.44 (0.38-0.49)</td>
</tr>
<tr>
<td>$^{6}$SUV$_{mean}$ SAT</td>
<td>0.73 (0.67-0.81)</td>
<td>0.73 (0.67-0.82)</td>
</tr>
<tr>
<td>$^{6}$SUV$_{mean}$ SAT</td>
<td>0.32 (0.29-0.34)</td>
<td>0.30 (0.27-0.36)</td>
</tr>
<tr>
<td>$^{6}$SUV$_{mean}$ SAT</td>
<td>0.37 (0.35-0.40)</td>
<td>0.37 (0.35-0.39)</td>
</tr>
</tbody>
</table>

Data presented as median and interquartile distance.

L=lumbar vertebral body; SAT=subcutaneous adipose tissue; SUV=standardized uptake values; VAT=visceral adipose tissue;

$^{6}$SUV$_{mean}$ =automated generated with the method with setting SUV threshold 1.9, erosion;

$^{6}$SUV$_{mean}$ =manually generated by drawing regions of interest.

Figure 3 | Reproducibility; $^{6}$SUV$_{mean}$ VAT of observer 1 plotted against those of observer 2 (A) and corresponding Bland-Altman plot (C). $^{4}$SUV$_{mean}$ VAT of observer 1 plotted against those of observer 2 (B) and corresponding Bland-Altman plot (C).

SD=Standard deviation; SUV=standardized uptake values; VAT=visceral adipose tissue

$^{4}$SUV$_{mean}$ =automated generated with the method with setting SUV threshold 1.9, erosion;

$^{6}$SUV$_{mean}$ =manually generated by drawing regions of interest.
Figure 4 | Repeatability; $^{a}$SUV$_{\text{mean}}$ VAT of scan 1 (test) plotted against those of scan 2 (restest) (A) and corresponding Bland-Altman plot (C). $^{B}$SUV$_{\text{mean}}$ VAT of scan 1 (test) plotted against those of scan 2 (restest) (B) and corresponding Bland-Altman plot (D).

SD=Standard deviation; SUV=standardized uptake values; VAT=visceral adipose tissue;  
$^{a}$SUV$_{\text{mean}}$ = automated generated with the method with setting SUV threshold 1.9, erosion;  
$^{B}$SUV$_{\text{mean}}$ = manually generated by drawing regions of interest.

Table 2 | Intraclass correlation coefficients of PET-LDCT data reproducibility and repeatability.

<table>
<thead>
<tr>
<th></th>
<th>Inter Observer 1</th>
<th>Inter Observer 2</th>
<th>Intra Observers</th>
<th>Repeatability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance L1-L5 (cm)</td>
<td>1.00</td>
<td>0.99 [0.97-0.99]*</td>
<td>0.97 [0.92-0.96]*</td>
<td>0.97 [0.89-0.99]*</td>
</tr>
<tr>
<td>VAT Volume (cm$^3$)</td>
<td>1.00 [0.99-1.00]*</td>
<td>1.00 [1.00-1.00]*</td>
<td>1.00 [0.99-1.00]*</td>
<td>1.00 [0.99-1.00]*</td>
</tr>
<tr>
<td>SAT Volume (cm$^3$)</td>
<td>1.00 [1.00-1.00]*</td>
<td>1.00 [1.00-1.00]*</td>
<td>1.00 [0.97-1.00]*</td>
<td>1.00 [0.98-1.00]*</td>
</tr>
<tr>
<td>$^{a}$SUV$_{\text{mean}}$ VAT</td>
<td>0.92 [0.68-0.98]*</td>
<td>0.97 [0.89-0.99]*</td>
<td>0.57 [-0.29-0.82]*</td>
<td>0.78 [0.20-0.94]*</td>
</tr>
<tr>
<td>$^{B}$SUV$_{\text{mean}}$ VAT</td>
<td>1.00 [1.00-1.00]*</td>
<td>1.00 [1.00-1.00]*</td>
<td>1.00 [0.94-1.00]*</td>
<td>0.98 [0.94-1.00]*</td>
</tr>
<tr>
<td>$^{a}$SUV$_{\text{mean}}$ SAT</td>
<td>0.95 [0.80-0.90]*</td>
<td>0.91 [0.66-0.98]*</td>
<td>0.91 [0.64-0.98]*</td>
<td>0.79 [-0.01-0.95]*</td>
</tr>
<tr>
<td>$^{B}$SUV$_{\text{mean}}$ SAT</td>
<td>0.97 [0.88-0.99]*</td>
<td>1.00 [1.00-1.00]*</td>
<td>0.99 [0.96-1.00]*</td>
<td>0.33 [-0.23-0.77]*</td>
</tr>
</tbody>
</table>

Data presented as Intraclass correlation coefficients and 95% Confidence Interval.  
L=lumbar vertebral body; SAT=subcutaneous adipose tissue; SUV=standardized uptake values; VAT=visceral adipose tissue.  
$^{a}$SUV$_{\text{mean}}$=automated generated with the method with setting SUV threshold 1.9, erosion;  
$^{B}$SUV$_{\text{mean}}$=manually generated by drawing regions of interest  
* indicates significance P value <0.001; ‡ indicates significance P value <0.05
DISCUSSION

The present study assessed the reproducibility and repeatability for the metabolic assessment of VAT and SAT using $^{18}F$-FDG-PET/CT imaging using both manual and semi-automated segmentation. The automated metabolic assessment of VAT was highly reproducible and repeatable. Moreover, the ICCs concerning the automated metabolic assessment of VAT, were superior to the manual method. The ICCs for automated and manually metabolic assessment of SAT were also highly reproducible. However, the repeatability of the automated metabolic assessment of SAT was lower than the manual method.

The present study investigated the repeatability of $^{18}F$-FDG uptake in VAT and SAT with a semi-automated segmentation which included a SUV threshold and erosion approach, with settings optimized for analysis of VAT. As expected, the $S_{\text{VAT}}^{\text{mean}}$ in VAT increased with higher SUV thresholds and decreased with larger erosions. However, the increase in $S_{\text{VAT}}^{\text{mean}}$ decreased with every 0.1 SUV increase in threshold. As a difference of $<0.01$ SUV was not considered relevant, this was used as a criteria to assess the most optimal threshold. In addition, since SUV in VAT are almost normally distributed (Supplemental Figure 2), the $S_{\text{VAT}}^{\text{mean}}$ as well as $S_{\text{VAT}}^{\text{median}}$ are reliable parameters. As both parameters were highly reproducible and repeatable, we preferred to report $S_{\text{VAT}}^{\text{mean}}$ as this is the most common parameter used to report $^{18}F$-FDG uptake in VAT.$^{18,20,23-25,27,30}$

Another criteria for the optimal threshold and erosion was that at least 50% of the CT based segmented VAT should remain for SUV analysis. This was based on the assumption that not more than 50% of the CT based segmented VAT would be influenced by spillover effects. Based on the results of this study, we suggest that for automated assessment of the metabolic activity of VAT, a SUV threshold should optimally be 1.9 for $S_{\text{VAT}}^{\text{mean}}$ or 1.5 for $S_{\text{VAT}}^{\text{median}}$ and an erosion should be 1 pixel and maximal 2 pixels.

The method was not fully automated since two manually actions were needed; selection of the slices corresponding to vertebral levels L1 to L5 and drawing a line to close the abdominal muscular layer to separate VAT and SAT. However, these manual actions barely affect the outcomes as VAT and SAT volume measurements were highly reproducible and repeatable (all ICC>0.97).

In order to improve CVD risk management associated with obesity, VAT is recognized as an important contributor. Clearly, VAT volume and metabolic activity are both linked to the CVD risk and have become targets of imaging modalities.$^{4,9,15,41}$ Two other studies used an automated method, in which a VOI generated on CT was transferred to PET, to report $^{18}F$-FDG uptake in VAT.$^{23,27}$ Interestingly, one of this studies showed that VAT $^{18}F$-FDG uptake was associated with the degree of intestinal uptake on PET/CT but not on PET-MRI.$^{27}$ Those findings confirm the need for a threshold and erosion for the automated metabolic assessment of VAT to overcome overspill effects from surrounding organs.
The $^{18}$SUV$_{\text{mean}}$ VAT was higher compared with $^{18}$SUV$_{\text{mean}}$ VAT. This result may be explained by the fact that manual ROIs were placed in the low $^{18}$F-FDG uptake areas, in an attempt to avoid spillover, and therefore potentially suffer from selection bias. The uptake of $^{18}$F-FDG in VAT is not uniform. Therefore, the uptake in an ROI may be not representative for the effective mean uptake of $^{18}$F-FDG in the whole VAT region. Furthermore, the current study showed that automated measurements of VAT were more accurate than manually drawn ROIs, as the reproducibly, especially intra observers, and the repeatability ICCs were much higher. Moreover, the automated measurement variation coefficient of the reproducibility between observers (0.6%) and the repeatability (2.5%) was far less compared with manual ROIs (19.2% and 12.6%, respectively).

Our study also has some limitations. First, this study included predominantly patients with a healthy (BMI <25) and no obese patients (BMI> 30). Therefore, it is uncertain if the automated method is also equally accurate in obese subjects. Secondly, the $^{18}$F-FDG uptake in VAT was not compared with levels of adipokines. Therefore, the hypothesis that the inflammatory state measured by $^{18}$F-FDG uptake in VAT is positively associated with adipokine levels could not be investigated. Further studies, which take levels of adipokines and other metabolic parameters into account, will need to be performed.

**CONCLUSION**

In summary, we conclude that a (semi-)automated method is feasible and should be the preferred approach for metabolic assessment of VAT in PET/CT $^{18}$F-FDG data.

**Acknowledgments**

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**Conflict of interest**

The authors declare that they have no conflict of interest.
REFERENCES


Supplemental Figure 1 | Each 3D plot represent 96 ICCs calculated for the different SUV thresholds (x-as) and erosions (y-as). The ICCs for interobserver reproducibility for $^{\Delta}$SUV$_{\text{median}}$ VAT (a) and for $^{\Delta}$SUV$_{\text{mean}}$ VAT (d). The ICCs for intraobserver reproducibility for $^{\Delta}$SUV$_{\text{median}}$ VAT (b) and for $^{\Delta}$SUV$_{\text{mean}}$ VAT (e). The repeatability ICCs for $^{\Delta}$SUV$_{\text{median}}$ VAT (c) and for $^{\Delta}$SUV$_{\text{mean}}$ VAT (f).
Supplemental Figure 2 | Distribution of SUV in VAT and SAT. Histogram with SUV values in VAT with different SUV thresholds and no erosion (A) and for different erosions and a SUV threshold of 2.0 (B). Histogram with SUV values in SAT with different SUV thresholds and no erosion (C) and for different erosions and a SUV threshold of 2.0 (D).
Part II
Clinical applications in type 2 diabetes