Impacts of Acquisition and Reconstruction Parameters on the Absolute Technetium Quantification of the Cadmium-zinc-telluride Based SPECT/CT System: A Phantom Study

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Abstract

Background

Various acquisition and reconstruction parameters may affect the accuracy of the absolute SPECT quantification. However, many of the impacts of these parameters have not well been studied. This study aimed to evaluate the impacts of acquisition parameters (main energy window and acquisition time per frame) and reconstruction parameters (the number of iterations and subsets in iterative reconstruction, post-filter, and image correction methods) on the technetium quantification of the cadmium-zinc-telluride based SPECT/CT system.

Methods

A phantom (PET NEMA/IEC image quality, USA) was filled with a 16:1 sphere-to-background activity concentration ratio of technetium and all spheres had 132400.81Bq/ml of radioactivity. Mean uptake values (calculated mean concentrations for spheres) were measured to evaluate the recovery coefficient (RC) changes under different acquisition and reconstruction parameters. Corresponding standard deviations of mean uptake values were also measured to evaluate the quantification error. Image quality was evaluated using the National Electrical Manufacturers Association (NEMA) NU 2-2012 standard.

Results

For six spheres of the phantom, significant correlations were found between iterations and RCs ($r=0.60~0.98$ for 1~35 iterations, $r=0.96~0.99$ for 35~90 iterations, all $P$-values $<0.05$) as well as between the full width at half maximum (FWHM) of the Gauss filter and RCs ($r=-0.90~1.00$, all $P$-values $<0.05$). 1~35 iterations had higher regression coefficients compared with those of 35~90 iterations (0.67~1.16 vs. 0.02~0.17). The AC (attenuation correction)+SC (scatter correction) +RR (resolution recovery correction) combination had more close to 100% RCs (42.42%~98.04%) with better image quality (31.52%~83.57%) than those of other correction combinations (all $P$-values $<0.05$). No significant statistical difference was found between the 15% energy window and the 20% energy window ($P$-value=0.061), nor between the 5 seconds/frame and 120 seconds/frame of acquisition time ($P$-value=0.943) in terms of RCs.

Conclusions

The CZT-SPECT/CT showed a good quantification accuracy of technetium. The favorable acquisition parameters may be 15% energy window and 40 seconds/frame of acquisition time. The favorable reconstruction parameters could be 35 iterations, 20 subsets, the AC+SC+RR correction combination, and FWHM 0.7mm of Gauss filter.

Background
The single photon emission computed tomography (SPECT) has been widely used to diagnose various kinds of human diseases such as myocardial diseases, endocrine disorders, central nervous system diseases, and so on since its invention in the 1990s[1–4]. Most of the available SPECT systems are based on the well-known Anger camera with NaI (Tl) as a scintillation material, which determines the position of an event by the centroid of the scintillation light[5]. NaI (Tl)-based detectors capture $\gamma$ photons and convert photons into electrons, which will be further amplified to strong electrical signals via photomultiplier tubes (PMT). This converting process introduces errors including photon loss, motion artifacts of long acquisition time, and higher radiation dosages. These years, digital radiographic imaging is surely replacing analog imaging. Digital imaging has many advantages such as better image contrast and image enhancement[6]. Compared with the NaI SPECT, a novel digital cadmium-zinc-telluride (CZT) based SPECT equipped with solid-state detectors generates electrical signals directly by turning incident $\gamma$ photons into electron-hole pairs under the high-voltage electric field[7]. This process avoids photon loss and produces better image quality due to its higher spatial and energy resolutions than those of the NaI SPECT[8]. The CZT SPECT provides a shorter acquisition time and a lower radiation dosage[9, 10].

The absolute quantification was originally applied in the positron emission computed tomography (PET). It is considered as the golden standard of non-invasive quantification analysis method for multiple diseases such as coronary artery disease, microvascular disease, and tumors due to high quantification accuracy[11, 12]. PET images demonstrate the distribution of certain radionuclides in three dimensions (3D), which is the foundation for quantifications. The data used for PET image reconstructions are in units of radioactivity per unit volume (kBq·cm$^{-3}$) and this data is close to the actual in-vivo distribution of the radionuclide because radionuclides applied in PET had higher energy and smaller fractions of scattered radiation than those of SPECT[13]. As a result, SPECT images may be more difficult to reconstruct.

The absolute quantification can also be applied to SPECT now. The study of Duvall, W.L., et al. suggested that SPECT myocardial perfusion imaging provides similar overall diagnostic accuracy when compared to coronary angiography[14]. The study of Collarino, A., et al. suggested that absolute SPECT/CT quantification of breast studies using $^{99m}$Tc-sestamibi was feasible with < 17% deviations[15]. Quantification can be represented as the mean standardized uptake value (SUVmean) or maximum standardized uptake value (SUVmax) of the volumes of interests (VOIs)[16]. There were four difficulties for quantifying the concentration of radioactivity for the SPECT system, including photon attenuation, photon scattering, partial volume effects, and motion artifacts. These problems have been recently solved with the development of SPECT image reconstruction, along with various corrections for the mentioned effects. These reconstruction methods could translate the count distribution of SPECT images into a measured activity distribution[17].

Various acquisition and reconstruction parameters may affect the accuracy of the NaI SPECT quantification. The study of He, B. suggested that acquisition time might be reduced at least by half with little effect on the errors in organ activity estimates[18]. The study of Gnesin, S., et al. suggested that mean uptake values were close to convergence at 16 iterations and 4 subsets[19]. The study of Kim, K.M.,
et al. suggested that the scatter correction method was useful and is recommended for more accurate quantification[20]. To our limited knowledge, many of the impacts of the image acquisition or reconstruction parameters on the absolute SPECT quantification have not well been studied, especially on the absolute CZT SPECT quantification. In this study, we evaluated the impacts of acquisition parameters including the main acquisition energy window and acquisition time/frame and reconstruction parameters including the number of iterations and subsets in iterative reconstruction, post-filter, attenuation correction (AC), scatter correction (SC), as well as resolution recovery (RR) correction on the accuracy of technetium quantification of the CZT SPECT/CT.

**Materials And Methods**

1. Phantom preparations

We filled $^{99m}$TcO$_4^-$ (Atomic Technology Corporation, China) into the phantom at a sphere to background activity concentration ratio of 16:1. All spheres had 132400.81 Bq/ml of radioactivity by the time of acquisition. The decay of $^{99m}$TcO$_4^-$ before the acquisition was calibrated[21].

2. Image acquisition parameters

SPECT/CT acquisition of the PET NEMA/IEC image quality phantom was performed on a Discovery NM/CT 670 CZT (GE Healthcare, USA), equipped with wide energy high resolution collimators. All SPECT images were acquired with the list mode. The step & shoot acquisition mode was performed by 360-degree rotations (120 seconds/6-degree per frame) with a matrix size of 128 × 128 without zoom. Two main energy windows (140 KeV±7.5% and 140 KeV±10%) were reconstructed by the list mode to evaluate the impacts of the main energy window on RCs. The scatter energy window was 120±5% KeV. CT images were acquired with 120 kVp tube voltage, 200 mA tube current, matrix size of 512 × 512, and 1.25 mm slice thickness.

3. Image reconstruction parameters

All images were reconstructed using the ordered subsets expectation maximization (OSEM) algorithm with 1 to 90 iterations and 2 to 30 subsets[22]. The range of FWHM of Gauss filter was performed with 0.2 to 6.99 mm. Correction methods used in this study included CT-based attenuation correction (AC), double energy window technique based scatter correction (SC), and point spread function based resolution recovery correction. Three image correction combinations were used to evaluate the impacts of image correction methods including AC+SC+RR, AC+SC, and AC+RR. List mode was applied to reconstruct acquisition time to 5 seconds/frame, 10 seconds/frame, 20 seconds/frame, 40 seconds/frame, 60 seconds/frame, 80 seconds/frame, 100 seconds/frame, and 120 seconds/frame.

4. Quantitative analysis

4.1 RC calculations
VOIs of six spheres were delineated using the inner edge of spheres of CT images as references (Fig. 1). Mean uptake values (Bq/ml) and corresponding standard deviations were automatically calculated three times by the Q.Metrix of GE-Xeleris 4.0 workstation (GE Healthcare, USA) and were shown as averages. RCs were calculated as Eq. (1)[19]:

\[
RC = \frac{\text{Mean measured radioactivity concentration}}{\text{Actual radioactivity concentration}} \times 100\%.
\]

4.2 Image quality evaluations

To assess the image quality, we calculated the percent contrast complying with the NEMA NU 2-2012 standard[23, 24]. The percent contrast \(Q_{H,j}\) for each hot sphere was calculated by using Eq. (2):

\[
Q_{H,j} = \frac{C_{H,j}/C_{B,j} - 1}{a_H/a_B - 1} \times 100\%.
\]

, where \(C_{H,j}\) is the average counts in the ROI for sphere \(j\), \(C_{B,j}\) is the average of the background ROI counts for sphere \(j\), \(a_H\) is the activity concentration in the hot spheres, and \(a_B\) is the activity concentration in the background.

5. Statistical analysis

All statistical analyses were performed by SPSS 23.0 (IBM, USA). All graphs were produced by Graphpad Prism 8.3.0 (GraphPad Software, USA). The relationships between RCs and the different number of iterations and subsets, FWHM, and acquisition time/frame were established by Pearson's rank correlation and linear regression analysis. RCs of three different correction combinations were compared using the two-way ANOVA test[25]. The comparison of RCs for different energy windows and acquisition time/frame was made by using the Paired t-test[26]. The comparison of the percent contrast of three different correction methods was also calculated using the Paired t-test. In this work, a P-value lower than 0.05 was considered statistically significant.

Results

1. The impacts of the number of iterations and subsets

Fig. 2 showed that the RCs of bigger spheres converged earlier compared to those of smaller ones, of which 37~17mmmm spheres converged at 35 iterations and 13mm and 10mm spheres converged at 85 iterations. Tab. 1 showed that there were significant positive correlations between RCs and iterations (r=0.60~0.98 for 1~35 iterations, r=0.96~0.99 for 35~90 iterations, all P-values <0.05). However, linear regression analysis showed that 1~35 iterations had much higher regression coefficients than those of
35~90 iterations (0.67~1.16 vs. 0.02~0.17). RCs could increase stably and rapidly within the first 35 iterations.

Fig. 3 showed that RCs did not increase rapidly along with the increasing number of subsets. RCs of bigger spheres (37mm~17mm) became stable after 20 subsets. Tab. 1 showed that Pearson r values of all spheres ranged from 0.65 to 0.95 (P-values of 28mm, 13mm, and 10mm <0.05). In linear regression analysis, regression coefficients of six spheres were 0.11, 0.21, 0.13, 0.15, 0.73, and 0.98 respectively.

2. The impacts of Gauss filter

In Fig. 4, RCs of all spheres declined significantly as the increasing FWHM (from 0.7mm to 6.99mm) of the Gauss filter. There were significant negative correlations between the FWHM of the Gauss filter and RCs for all spheres (r=-0.90~-1.00, all P-values <0.05). Also, there were high regression coefficients in all spheres (-5.38 ~ -11.66) (Tab. 1). Furthermore, there was no plateau of FWHM in terms of RCs, different from iterations or subsets.

3. The impacts of image correction methods

Fig. 5 showed that the AC+SC+RR correction combination had good agreements with the actual sphere activity concentration. The AC+RR combination predicted the highest mean uptake values, while the AC+SC combination had the lowest mean uptake values in spheres. As for locations without radionuclide like the lung insert in the middle of the phantom, the actual radioactivity concentration was 0 Bq/ml. The AC+SC combination method tended to overestimate this radioactivity and the calculated mean uptake values of the AC+SC+RR combination were close to 0 Bq/ml (Fig. 6). Tab. 2 showed that the RCs results of the AC+SC+RR (42.42%~98.04%) combination and the AC+RR (52.36%~111.97%) combination were higher than those of the AC+SC (17.64%~62.14%) combination (P-value=0.013). Fig. 7 showed the visual difference of the images reconstructed with different correction combinations. The AC+SC+RR combination had a better visual image quality. Tab. 3 showed that the percent contrasts of six spheres reconstructed using the AC+SC+RR combination were higher than those of other correction combinations (AC+SC+RR vs. AC+RR, P=0.003, AC+SC+RR vs. AC+SC, P=0.002).

4. The impacts of the main energy window

As shown in Tab. 4, the RCs of most spheres were higher under the 15% energy window compared with those of the 20% energy window. However, there was no significant statistical difference (P-value=0.061).

5. The impacts of acquisition time per frame

There were no significant correlations between RCs and acquisition time/frame (r: -0.54~0.98) except for 28mm and 22mm spheres (0.98 and 0.78 respectively, P-values of both spheres <0.05). Regression coefficients of all spheres were close to 0 (Tab. 1). Fig. 8 and Tab. 5 showed that RCs had no observable changes through different acquisition time/frame. However, standard deviations of mean uptake values decreased significantly in the first 40 seconds/frame (Fig. 9). There was no significant statistical
difference in terms of RCs between 5 seconds/frame and 120 seconds/frame of acquisition time (P=0.943, Fig. 8). Tab. 5 also showed that RCs could achieve up to 97.98% for the 37mm sphere, under the optimal 40 seconds of acquisition time and other optimal reconstruction and acquisition parameters: 35 iterations, 20 subsets, Gauss filter (FWHM: 0.7mm), AC+SC+RR combination, 15% energy window.

**Discussion**

In this study, CT images were applied as references to avoid the partial volume effect of the SPECT system and calculate RCs with lower errors[27]. The study of Dr. Koole, M., et al. suggests that high-resolution structural information from the MR or CT images is helpful in determining the potential structure interfaces in the SPECT images[28].

In this work, it showed that the number of iterations had a big impact on quantifications. Figure 2 showed that RCs of bigger spheres converged earlier compared to smaller ones. This indicated that bigger spheres required fewer iterations in absolute quantification. Although the correlations between RCs and 1 ~ 35 iterations were lower than those of 35 ~ 90 iterations, 1 ~ 35 iterations had much higher regression coefficients than those of 35 ~ 90 iterations. RCs could increase stably and rapidly within the first 35 iterations for all spheres (Fig. 2). This indicates that although 35 ~ 90 iterations had strong linearity, it could not increase RCs efficiently because of much smaller regression coefficients compared with those of 1 ~ 35 iterations. Smaller spheres had relatively bigger errors and more iterations were helpful in terms of RCs, but not efficiently. Ultimately, it is determined that the optimal iterations might be 35 times.

The correlations between subsets and RCs were not obvious because the P-values of half of the spheres (37mm, 22mm, and 17mm spheres) were not statistically significant (P-values > 0.05, Table 1). Besides, regression coefficients of 37mm, 28mm, 22mm, and 17mm spheres were much lower (0.11, 0.21, 0.13, and 0.15 respectively). This indicates that subsets had a relatively small impact on quantifications. The study of Dr. Vriens, D., et al. also suggested that subsets have only a small effect on the SUV (Standardized concentration) in phantom experiments[29]. In this study, RCs tended to be stable after 20 subsets for bigger spheres (37mm ~ 17mm) and did not increase significantly after 20 subsets for smaller spheres (13mm and 10mm spheres). Because subsets are not strongly correlated with RCs and bigger subsets could reduce the image reconstruction time, 20 subsets were applied in this study.

Among all reconstruction parameters, the FWHM of the Gauss filter showed the most significant correlations (All Pearson's r <-0.90) as well as the highest regression coefficients (-5.38 ~ -11.66) with RCs (Table 1). This indicates that the Gauss filter also played a very essential role in quantifications. This study showed there was no plateau of FWHM in terms of RCs. RCs increased along with the decrease of FWHM. Smaller FWHM values had higher RCs within the range from 0.7mm to 6.99mm. In this study, the optimal Gauss filter (FWHM: 0.7mm) was used to calculate the closest RCs for clinical guidelines with good image quality.

The best correction combination was AC + SC + RR. It presented a higher concentration concordance in bigger spheres and lung insert (Fig. 5 and Fig. 6). In smaller spheres, the AC + RR method had better
performance. However, it resulted from the compensation of scattered photons with inaccurate energy and position information. Since the scattered photons account for 30–40% of all photons acquired by the detector, the application of scatter correction can reduce the errors of the calculated concentration to a great extent[30]. The combination of AC + SC methods presented the worst visual image quality, underestimated concentration in spheres, and overestimated concentration in the lung insert. It is suggested that RR correction is essential for quantifications (Fig. 5, Fig. 6). This study also showed that the AC + SC + RR combination showed a better image quality than those of other correction combinations. Percent contrasts of AC + SC + RR corrected images were much higher than those of other correction combinations (all P-values < 0.05). This indicates that the AC + SC + RR combination provided more accurate quantification with improved image quality to a great extent. Several reports also suggested the significance of AC, SC, and RR for SPECT equipment[31–34].

It could also be found that the 15% energy window achieved around 1% higher RCs, compared to those of the 20% energy window. However, there was no significant statistical difference (P-value = 0.061, Table 4). This suggested that although CZT SPECT/CT has a better image resolution due to the improved energy resolution of the new solid-state crystals[35], a 15% energy window is not enough to generate RCs with a significant statistical difference when comparing the traditional 20% energy window. The reason behind this remains to be discovered.

This study showed that there were no significant correlations between RCs and acquisition time (r: -0.54 ~ 0.98) except for 28mm and 22mm spheres (P-values < 0.05). Regression coefficients of all spheres were close to 0 (Table 1). There was no significant statistical difference for RCs between images acquired by 5 seconds/frame and 120 seconds/frame. However, standard deviations could be rapidly reduced within the optimal acquisition time (40 seconds/frame), which means acquisition time only imposed a strong impact on the quantification accuracy within this range. Though different acquisition time had a small impact on quantification, a lower level of standard deviation means less noise and better image quality. The RC of the 37mm sphere reached 98.04% under the 120 seconds/frame and reached 97.98% under the 40 seconds/frame of acquisition time(Table 5). In practice, 40 seconds acquisition time/frame should satisfy the requirement of quantifications.

The RC of the 37mm sphere reached 97.98% under the best acquisition and reconstruction parameters. This coefficient dropped dramatically as the sphere volume decreased, 47.87% in the 10mm sphere. One possible reason is that the VOI counts decreased significantly with smaller objects due to the limitations introduced by the spatial resolution [36].

Quantitative SPECT offers meaningful information that could provide clear benefits for clinical diagnosis including longitudinal assessment of disease pre and post-intervention and dosimetry assessments before radionuclide therapy[37]. Recently the SPECT quantification is more and more widely used with the rapid development of SPECT instruments with high accuracy. In addition, radionuclides used for SPECT quantification are very economical with a relatively long half-life and good availability[38]. In conclusion, the SPECT quantification shows advantages in clinical quantification.
There were three limitations to this study. First, the quantification analysis was performed based on a 16:1 sphere to background ratio. Other ratios were not performed in this study and will be a future plan. Second, due to the purpose of calculating mean uptake values with the lowest errors and finding out the impacts of different acquisition and reconstruction parameters, VOIs were delineated using CT images as references. This might be limited in clinical usage. Last, quantification measurements were only performed with a CZT-based camera system and not with a NaI (Tl)-based camera system, so a comparison between them was not evaluated.

**Conclusions**

CZT-SPECT/CT showed a good quantification accuracy of technetium. The favorable acquisition parameters may be the 15% energy window and 40 seconds/frame. The favorable reconstruction parameters could be 35 iterations, 20 subsets, the AC+SC+RR correction combination, and FWHM 0.7mm of Gauss filter. Our results might have some merit for the clinical quantification guidelines.

**Abbreviations**

SPECT, Single photon emission computed tomography;

CZT, Cadmium-zinc-telluride;

RC, Recovery coefficient;

NEMA, National Electrical Manufacturers Association;

FWHM, Full width at half maximum;

AC, Attenuation correction;

SC, Scatter correction;

RR, Resolution recovery correction;

NaI, Sodium iodide;

PMT, Photomultiplier tubes;

PET, Positron emission computed tomography;

SUVmean, Mean standardized uptake value;

SUVmax, Maximum standardized uptake value;

VOI, Volume of interest;
OSEM, Ordered subsets expectation maximization;

**Declarations**

**Ethics approval and consent to participate**

Not applicable

**Consent for publication**

Not applicable

**Availability of data and materials**

The datasets used and/or analysed during the current study are available from the corresponding authors on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

**Funding**

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**Authors' contributions**

RZ, MW contributed to the design of this study. Material preparation, data collection, and analysis were performed by RZ. The first draft of the manuscript was written by RZ. All authors contributed to manuscript revision, read, approved the submitted version, and agreed to be accountable for all aspects of the research in ensuring the accuracy of this study. Corresponding authors ZM and QJ contributed equally to this study.

**Acknowledgements**

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**References**


Tables
Tab. 1 Correlation and linear regression analysis of RCs among different acquisition and reconstruction parameters

<table>
<thead>
<tr>
<th></th>
<th>37mm</th>
<th>28mm</th>
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<th>17mm</th>
<th>13mm</th>
<th>10mm</th>
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<tbody>
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<td><strong>Iterations (1~35)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Regression coefficient</td>
<td>0.80</td>
<td>0.88</td>
<td>0.90</td>
<td>1.16</td>
<td>1.12</td>
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<tr>
<td>Pearson r</td>
<td>0.60*</td>
<td>0.65*</td>
<td>0.68*</td>
<td>0.82*</td>
<td>0.94**</td>
<td>0.98**</td>
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<tr>
<td><strong>Iterations (35-90)</strong></td>
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<tr>
<td>Regression coefficient</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
<td>0.02</td>
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<td>0.17</td>
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<tr>
<td>Pearson r</td>
<td>0.97**</td>
<td>0.99**</td>
<td>0.98**</td>
<td>0.96**</td>
<td>0.98**</td>
<td>0.99**</td>
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<tr>
<td><strong>Subsets</strong></td>
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<tr>
<td>Regression coefficient</td>
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<td>0.21</td>
<td>0.13</td>
<td>0.15</td>
<td>0.73</td>
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<td>Pearson r</td>
<td>0.72</td>
<td>0.92**</td>
<td>0.73</td>
<td>0.65</td>
<td>0.87*</td>
<td>0.95**</td>
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<tr>
<td><strong>FWHM</strong></td>
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<tr>
<td>Regression coefficient</td>
<td>-9.98</td>
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<td>-10.57</td>
<td>-8.72</td>
<td>-7.47</td>
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<tr>
<td>Pearson r</td>
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<td>-0.99**</td>
<td>-0.98**</td>
<td>-0.97**</td>
<td>-0.93**</td>
<td>-0.90**</td>
</tr>
<tr>
<td><strong>Acquisition time</strong></td>
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<td>Regression coefficient</td>
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<td>&lt;0.01</td>
<td>&lt;0.01</td>
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<tr>
<td>Pearson r</td>
<td>0.69</td>
<td>0.98**</td>
<td>0.78*</td>
<td>-0.50</td>
<td>-0.03</td>
<td>-0.54</td>
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</table>

**, P-value <0.001; *, P-value <0.05.

Tab. 2 Comparison of RCs (%) of all spheres among three different correction combinations

<table>
<thead>
<tr>
<th></th>
<th>37mm</th>
<th>28mm</th>
<th>22mm</th>
<th>17mm</th>
<th>13mm</th>
<th>10mm</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>AC+SC+RR</td>
<td>98.04</td>
<td>96.14</td>
<td>80.83</td>
<td>64.58</td>
<td>55.62</td>
<td>42.42</td>
<td>0.013</td>
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<tr>
<td>AC+RR</td>
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<td>107.37</td>
<td>90.81</td>
<td>73.39</td>
<td>66.73</td>
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<tr>
<td>AC+SC</td>
<td>62.14</td>
<td>63.34</td>
<td>50.22</td>
<td>35.34</td>
<td>23.91</td>
<td>17.64</td>
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Reconstruction parameters: 35 iterations, 20 subsets, 0.7mm of FWHM of Gauss filter; Acquisition parameters: 120 seconds/frame of acquisition time, 15% main energy window.

Tab. 3 Comparison of the percent contrast of all spheres among three different correction combinations
<table>
<thead>
<tr>
<th></th>
<th>37mm</th>
<th>28mm</th>
<th>22mm</th>
<th>17mm</th>
<th>13mm</th>
<th>10mm</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC+SC+RR</td>
<td>83.57</td>
<td>79.13</td>
<td>61.62</td>
<td>59.00</td>
<td>51.48</td>
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<tr>
<td>AC+RR</td>
<td>61.77</td>
<td>58.76</td>
<td>45.60</td>
<td>43.95</td>
<td>38.73</td>
<td>29.02</td>
<td>0.003</td>
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<tr>
<td>AC+SC</td>
<td>70.26</td>
<td>68.77</td>
<td>50.84</td>
<td>38.42</td>
<td>23.27</td>
<td>12.75</td>
<td>0.002</td>
</tr>
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</table>

Reconstruction parameters: 35 iterations, 20 subsets, 0.7mm of FWHM of Gauss filter; Acquisition parameters: 120 seconds/frame of acquisition time, 15% energy window.