《研究速報》

Myocardial Scintigram with Thallium-201: Basic Investigation of the Interpolative Background Subtraction Method

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Recently developed myocardial imaging with ^{201}Tl is useful for evaluation of coronary heart disease. But inherent low myocardial-to-background ratios obscure the detailed evaluation of image. Therefore nontarget background is generally handled by subtraction across the broad (threshold setting) or by delinearization of display responce (contrast enhancement).

Goris et al[1] recently reported a method of interpolative background subtraction for ^{201}Tl myocardial images. The images so processed have no background activity and implication was that lesion detection was improved and clinical usefullness was great.

We used animal models to determine precisely true myocardial component of ^{201}Tl images and compared these true myocardial images with interpolative background subtracted myocardial images.

Material and Method

We used three rabbits (weight 1.90–2.12 kg). ^{201}TlCl (1–2 mCi) was injected into an auricular vein. Fifteen minutes later, the animal was sacrificed with injection of sodium pentobarbital, and chest was opened. The aorta, cavae, pulmonary artery and pulmonary veins were doubly ligated and cut. An endotracheal tube was inserted and lungs expanded.

Myocardial imaging was performed in the anterior position. The scintillation camera equipped with pinhole collimator was interfaced to the minicomputer (Scintipac-230); the energy window was centered over 80 KeV.

After the initial image, the heart was removed, then a wate-rfilled balloon with equal dimension was substituted for the heart. And imaging was repeated for the same time required for the initial image (true background). Care was taken to ensure that the animal was not moved relative to the camera between images.

Using these images, new two myocardial images were displayed (Fig. 1); (A) true heart image: subtraction of true background from the initial image, (B) interpolative background subtracted image. In the latter, background was calculated as shown in Figure 2.

These two heart images were analysed as follows.

(1) Comparison of profile curves which were generated by placing a cursor over several same parts of both true and interpolative background subtracted image (Fig. 3).

(2) Comparing myocardial counts between two heart images (A and B).

Myocardial counts were defined as average counts of neighboring four matrix points which were set randomly over the same region of two heart image in each animal. In each animal, ten regions were selected for comparing myocardial counts.

Furtheremore, Myocardial counts of true heart images were compared with those of the images which were made by subtraction of appropriately set constant-average-background from the initial images.

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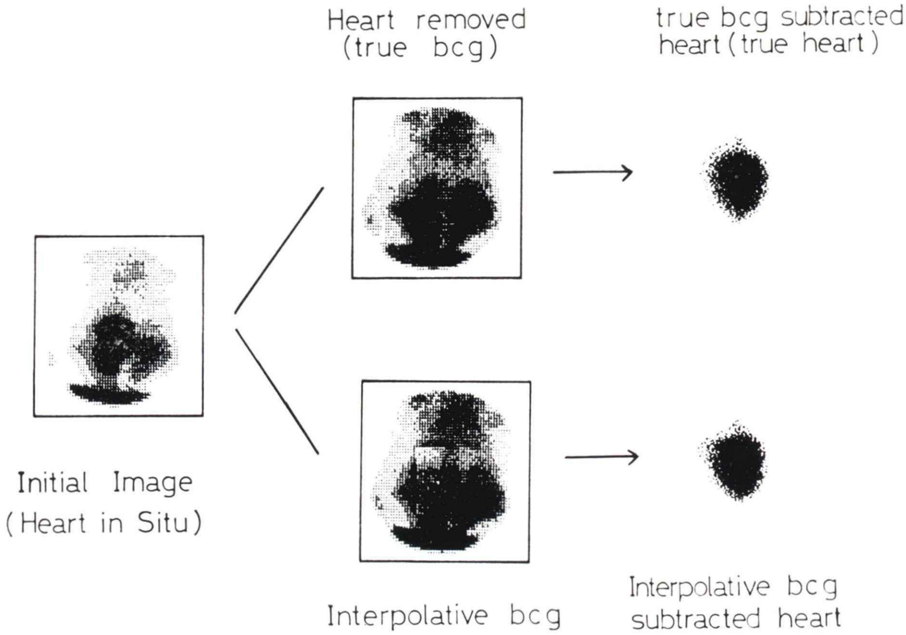
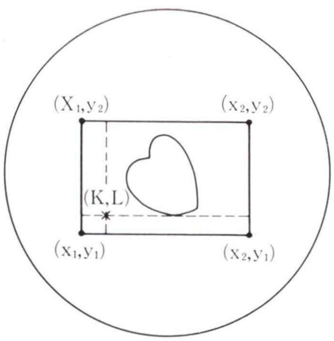


Fig. 1 New two myocardial images were made by subtraction of true background or subtraction of interpolative background. bcg: background



$x_1 < k < x_2$

$y_1 < L < y_2$

$$\mathrm{Bcg}\,(K, L) = \frac{\mathrm{Bcg}\,y + \mathrm{Bcg}\,x}{2}$$

$$\mathrm{Bcg}\,y = C(K, y_1) + [C(K, y_2) - C(K, y_1)]\,\frac{(L - y_2)}{(y_2 - y_1)}$$

$$\mathrm{Bcg}\,x = C(x_1, L) + [C(x_2, L) - [C(x_1, L)]\,\frac{(K - x_1)}{(x_2 - x_1)}$$

Fig. 2 Interpolative background subtraction method. Background for each matrix in cardiac area was calculated by linear interpolation from orthogonal coordinates overlying preselected region in the pericardiac area.

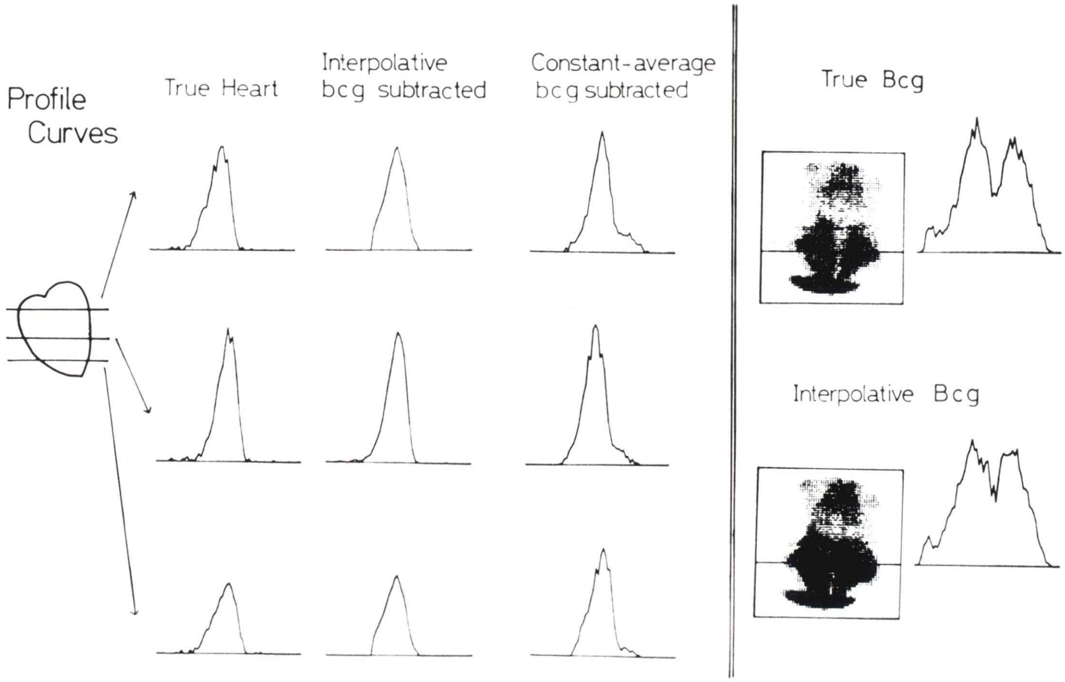


Fig. 3 Upper: Comparison of profile curves between true heart, interpolative background subtracted and average-constant background subtracted images.
Lower: Comparison of true background and interpolative background.

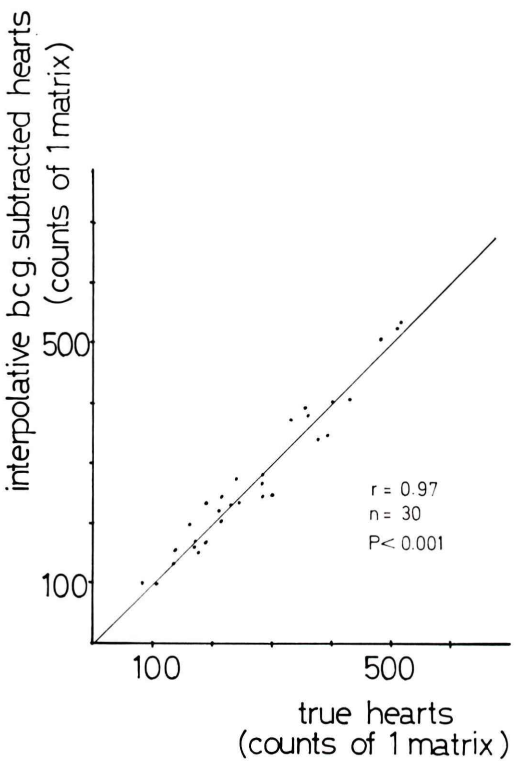
Results and Discussion

The images obtained from all animalls were similar. Figure 1 presents those obtained from Rabbit 2. Variations of precordial x, y axes setting for background subtraction exerted little effect upon obtained myocardial images. Visually true and interpolative subtracted images were similar. This was confirmed by comparison of profile curves (Fig. 3), which showed that counting rates between true heart image and interpolative background subtracted image were identical over several parts of the heart.

Comparison of myocardial counts between true heart image and constant-average-background subtracted image showed high correlation ($r=0.82$–0.79). However, there was more excellent correlation ($r=0.97$, 0.97, 0.95 $p<0.01$) in myocardial counts between true heart and interpolative background subtracted image (Fig. 4).

Recently Narahara et al[2] performed similar experiments, in which they reported that interpolative background subtraction method was not only troublesome but this method overestimated background, and that the simple threshold subtraction method would be more reasonable than the interpolative method. Although there were some differences between their experiments and ours (animal species, used collimator), it is difficult to consider that these differences essentially influenced on the background activity. And clearly, background contribution to the myocardial image is not constant (Fig. 3), therefore subtraction of constant-average-background method introduced artefact as shown in Fig. 3. Therefore, interpolative method was superior to the simple threshold method. And in the clinical application of myocardial scintigraphy, the procedure seems to be helpful in the interpretation of the data.

But in our experiments, myocardial Tl uptake ratio (4.0–5.0% of injected Tl) was higher than the previously reported one[3]. This provided with higher myocardial-to-background ratio than usual human resting scintigram. This may contribute to



excellent correlation between true heart image and interpolative background subtracted image. So hereafter we will attempt similar experiments in the condition of low myocardial-to-background ratio (eg. low oxygen breathing, experimental myocardial infarction) to verify the usefullness of interpolative method in various clinical situations.

References

1) Goris ML, Daspit SG, McLanghlin P et al: Interpolative background subtraction. J Nucl Med **17**: 744–747, 1976
2) Narahara KA, Hamilton GS, Williams DL et al: Myocardial imaging with thallium-201. J Nucl Med **18**: 781–786, 1977
3) Strauss HW, Harrison K, Langan JK et al: Thallium-201 for myocardial imaging. Circulation, **51**: 641–645, 1975

Fig. 4 Comparison of myocardial counts between true heart images and interpolative background subtracted images.

要 旨

補間法によるバックグラウンド除去心筋シンチグラム
——その基礎的研究——

Myocardial Scintigram with Thallium-201: Basic Investigation of the Interpolative Background Subtraction Method

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^{201}Tl 心筋シンチグラムは，虚血性心疾患の診断に有用な方法であるが，しばしば，バックグラウンドの存在が，シンチグラムの解釈を困難とする．そのため，これらバックグラウンド除去を目的とし，interpolative background subtraction を行ない，本法の有用性を，3匹の家兎を用いて検討した．

家兎耳静脈より ^{201}TlCl (1–2 mCi) を静注，15分後屠殺し，pinhole collimator を用い，まず heart in situ の状態で，心筋イメージングを行なった (original image). 次いで心臓を取り除き，イメージングした (true background). original image より true background を差し引いた true heart image と，original image より interpolative background を差し引いたイメージを作成，この両者を比較検討した．両イメージは視覚上同一であり，profil curve，心筋カウント数の比較でもよく一致した．

また interpolative background 法は，constant-average-background 法よりすぐれていた．

Key wards: myocardial scintigram, interpolative background subtraction