Prone Decubitus: A Solution to Inferior Wall Attenuation in Thallium-201 Myocardial Tomography

Jean-Paul Esquerré, Florent J. Coca, Serge J. Martinez, and Robert F. Guiraud

Sevice de Médecine Nucléaire, Hôpital Purpan, Place Baylac, 31059 Toulouse Cedex, France

We propose an efficient method to suppress inferior wall attenuation in ^{201}Tl 180° myocardial tomography. We systematically performed redistribution studies in both supine and prone decubitus, assuming that the latter should result in shifting with respect to each other's cardiac structures and diaphragm as well as subphrenic organs possibly responsible for attenuation. The comparison of both studies in 25 normal subjects by visual interpretation and circumferential profiles analysis showed a complete suppression of significant attenuation in the inferior wall in prone studies. In addition and consequently, the standard deviation of activity in this area was markedly reduced and became close to its value in anterior and lateral walls. This simple technique now routinely performed in over 400 patients drastically improves specificity in the evaluation of inferior wall abnormalities by suppressing attenuation artifacts and, incidently, the effect of high individual variability in left phrenic and subphrenic anatomic configuration.

J Nucl Med 30:398–401, 1989

The so-called diaphragmatic attenuation has been reported by several authors as a difficulty inherent in thallium-201 (^{201}Tl) myocardial scintigraphy (*1*, *2*). This problem is not yet solved in ^{201}Tl 180° myocardial SPECT (*3*) which fairly often shows more or less reduced thallium activity in the inferior wall (IW) of normal patients. This leads to an impairment of sensitivity or specificity depending on how the problem is perceived by the physician: poor sensitivity for those who are aware of it, poor specificity for those who underestimate it. It results in a very uncomfortable situation when one has to decide whether an IW abnormality is significant or not, particularly because of the wide s.d. of the apparent uptake in this area. Thus, a method minimizing attenuation artifacts should be desirable.

We assumed that prone decubitus could result in shifting with respect to each other's cardiac structures and diaphragm as well as subphrenic organs, such as stomach and spleen, so that performing tomographic acquisition in this position would minimize the interposition of these tissues and organs between the IW and the camera detector.

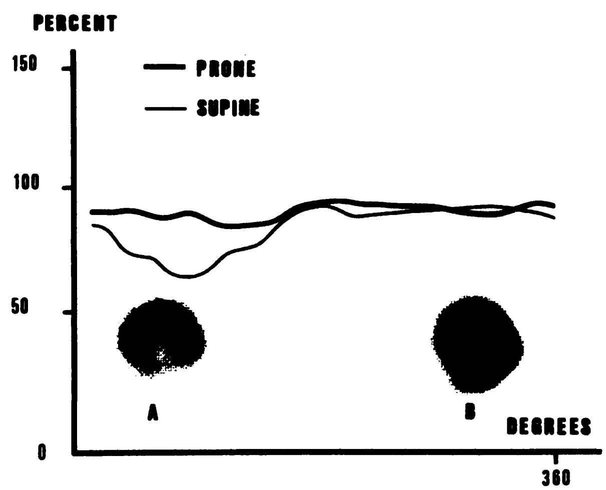

FIGURE 1
Two homologous short axis slices of the same patient obtained in the supine (A) and prone (B) positions and their respective circumferential profiles. Note the obvious improvement of detection in the IW. Differential attenuation is no longer present.

Received July 6, 1988; revision accepted Oct. 27, 1988.

For reprints contact: J.P. Esquerré, Service de Médecine Nucléaire, Hôpital Purpan, Place Baylac, 31059 Toulouse Cedex–France.

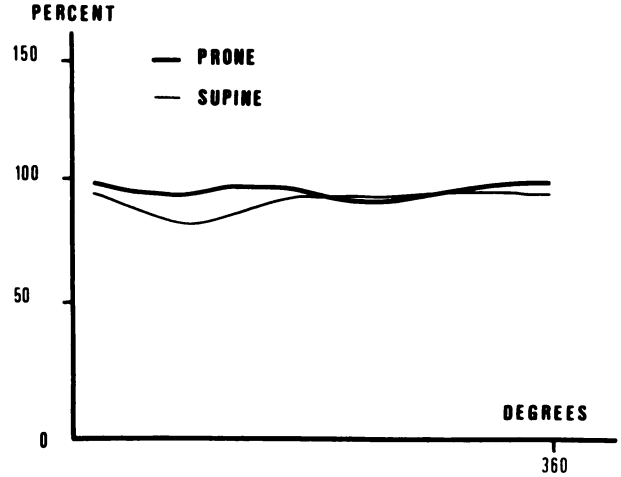

FIGURE 2
Mean circumferential profiles in both positions.

METHODS

To test this assumption we systematically performed ^{201}Tl redistribution single photon emission computed tomography (SPECT) studies in both supine and prone positions in 76 patients (67 M, 9 F) for diagnosis of coronary artery disease (CAD). We selected the redistribution studies so that the possible difference observed should be essentially a result of conditions of detection rather than the possible redistribution that might occur between both acquisitions immediately after stress. Among them, 25 (21 M, 4 F) were a posteriori considered as normal on the basis of normal stress ECG and coronary arteriography; their results will be presented in this paper.

A dose of 40 μCi per kilo was injected at peak exercise and the patients continued to exercise ~60 sec after injection. We acquired 32 projections during 20 min of a continuous rotation of 180° from the 45° right anterior oblique (RAO) to the left posterior oblique (LPO). For redistribution studies, a second acquisition was immediately performed after positioning the patient in prone decubitus and shifting the parameters of camera rotation by 180°.

For both studies, 7.2-mm-thick transverse slices were reconstructed and reoriented to generate short axis slices using the algorithms available in our system (C.G.R. Gammatome I). We did not use any attenuation correction.

For each study of the same patient a medioventricular thick 1.4 cm ($\simeq 2 \times 7.2$ mm: double thickness slices) short axis slice was then selected at the same anatomic level. Comparison using visual interpretation and maximum counts circumferential profiles (CPs) analysis was performed after normalization for statistical analysis. The method of normalization will be described later since it has been eventually designed according to the preliminary results of the study. The CPs analysis was performed according to the technique described by Garcia et al. (*3*). Using their convention, the IW profile is located in the first half of the curve, around 90°; 0° and 180° correspond to the middle of respectively septum and lateral walls.

RESULTS

Visual Interpretation

Supine studies. Among the 25 normal patients, 17 presented a more or less reduced activity in the IW.

Prone studies. None of the patients presented a significantly reduced activity in the IW. Besides, inferior septum and IW often appeared thicker.

Circumferential Profiles Analysis

Supine studies. As expected from visual findings, the CPs showed a more or less marked upwards concavity of the first half of the curve for the 17 patients, spreading around 90°. The second half was almost flat except in a few cases when diaphragmatic attenuation was particularly important. In the eight other patients, the CPs were almost horizontal.

Prone studies. In one patient, we did not individualize a depression of the CP specific of the IW. All CPs

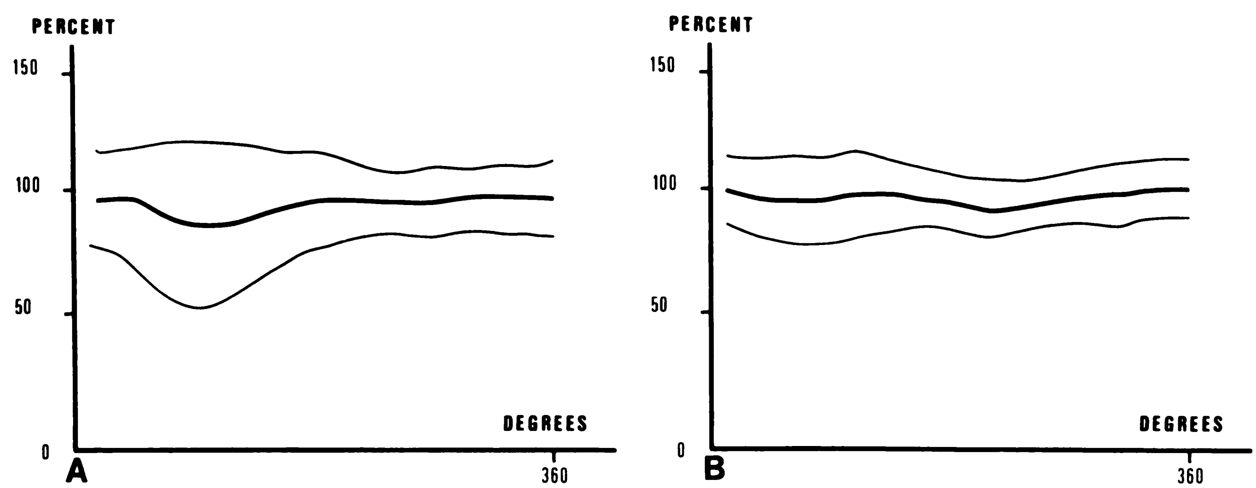

FIGURE 3
A: Mean supine circumferential profile ± 2.5 s.d. Note the important widening of s.d. in the IW. B: Mean prone circumferential profile ± 2.5 s.d. Note the important decrease of s.d. in the IW.

were horizontal in the limits of statistic fluctuations. Figure 1 shows the results in any of the most typical patients of our study.

Statistical Analysis of Circumferential Profiles

As said before, statistical analysis of CPs requires a normalization. Since in our preliminary results prone CPs were almost horizontal, their normalization was achieved by setting to 100% the mean value of the 60 points of the CP. Since supine CPs were almost horizontal in their second half, which is not or little affected by diaphragmatic attenuation, their normalization was achieved by setting to 100% the mean value of the 30 last points of the CPs. Figure 2 shows both mean CPs. The mean supine CP presents a depression around 90° with a minimum at 84% and is almost flat, close to 100% along its second part. The mean prone CP is almost horizontal, close to 100%. It is to be noticed that these two curves are strictly the average of individual normalized CPs; they were not themselves normalized after averaging. The good superimposition of the second halves of the CPs should be an indirect a posteriori validation of the method of normalization.

Figure 3A shows the mean supine CP ± 2.5 s.d. The SD varies from a maximum of 13.7% corresponding to the minimum of the CP to a minimum of ~5% corresponding to the horizontal part of the CP.

Figure 3B shows the mean prone CP ± 2.5 s.d. The SD is nearly constant along the whole CP. It presents a slight widening in the IW with a maximum at 7.5% and decreases to ~5% for the rest of the curve.

The comparison of both sets of curves shows a good superimposition of both confidence intervals in the anterior and lateral walls which are not affected by diaphragmatic attenuation. On the contrary, it clearly shows the reduced lower limit for supine CP in the IW, while the lower limit of prone CP exhibits little change.

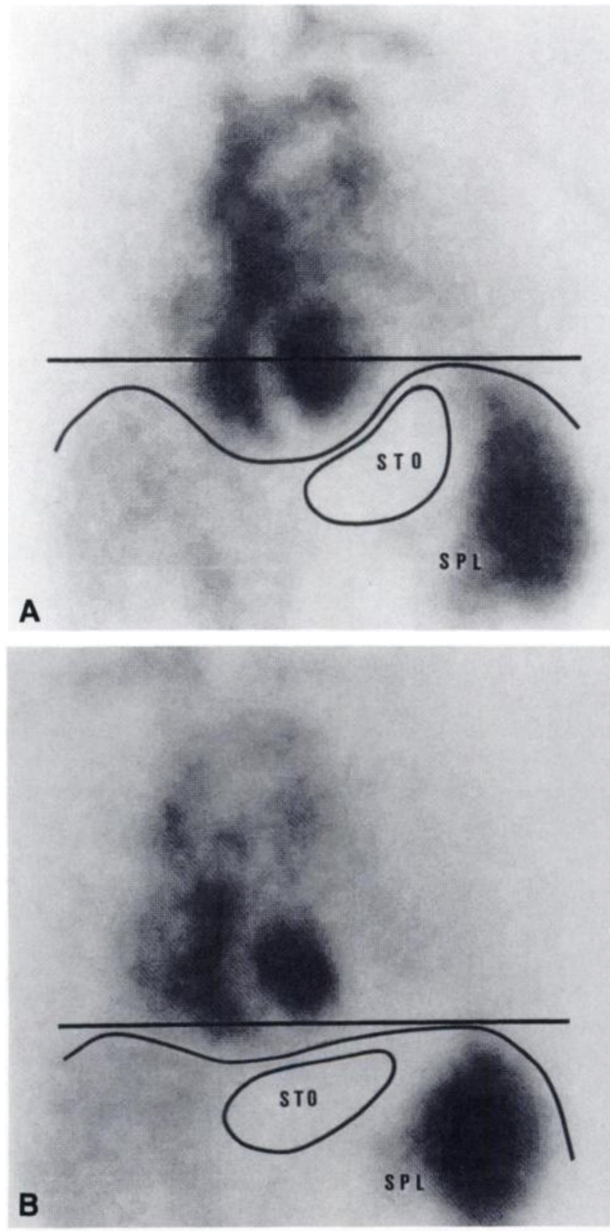

FIGURE 4
Gated radionuclide ventriculography performed in patient of Figure 1 in supine (A) and prone (B) positions. Note how stomach (STO) and spleen (SPL) appear shifted down in the prone study. Stomach is not visible on this document. However, the region of interest corresponds to its actual position. It has been outlined on the gray scale video monitor on which stomach appears as a photopenic area since we use in vivo red cells labeling after ingestion of potassium perchlorate to avoid uptake of free pertechnetate by stomach mucosa.

DISCUSSION

The results of our study concerning usual supine tomography are in agreement with literature (*3*). They account, first, for a frequent inferior wall attenuation and, second, as shown by the widening of SD in the area of decreased activity, for an important individual variability of this attenuation.

The results in prone decubitus clearly demonstrate the efficiency of this simple technique. In our department, we now perform all thallium myocardial tomographies using the prone position. We have already performed over 400 prone studies. A clinical evaluation of sensitivity and specificity in the detection on IW abnormalities is in progress, but from now on the improvement is obvious in so far as we do not any more have to face the problem of questionable IW abnormalities which is almost daily when using supine position. Until now, we only encountered two cases of mildly reduced activity mainly due to enlarged and filled stomachs uncompletely shifted down by prone position. In most cases however, prone decubitus markedly modifies anatomic configuration of subphrenic organs with respect to cardiac structures, as shown in Figure 4. This gated radionuclide ventriculography has

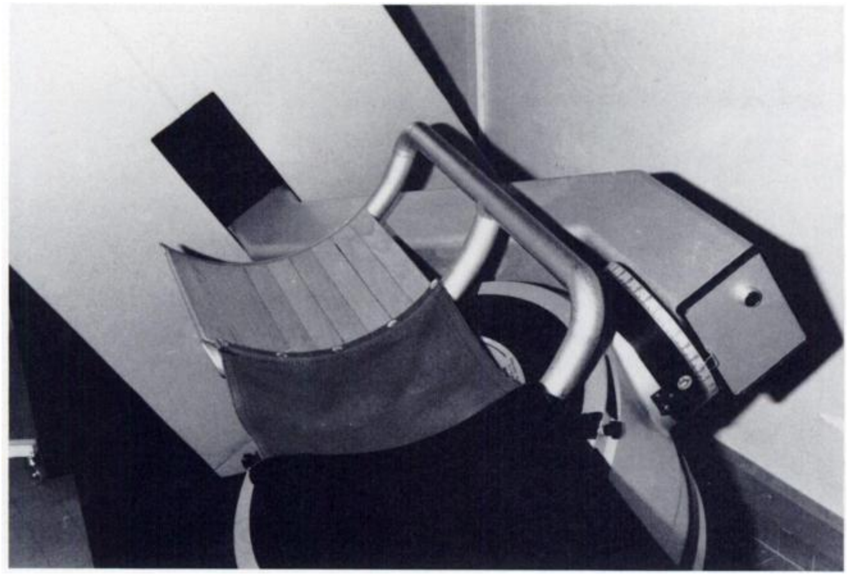

FIGURE 5
The dedicated imaging table designed in our institution: the anterior part on which patient upper thorax and head lie is overhanging by means of a single right arm. Thus there is no attenuating material except the cloth window between thorax and camera detector during the 180° rotation.

been performed in the patient of Figure 1. It demonstrates, first how important can be the interposition of subphrenic organs between heart and camera, explaining the important apparent defect in the IW and, second, how these organs look shifted down in prone decubitus resulting in much more suitable conditions for photons detection from the IW.

Another advantage of this position concerns the patient comfort. The upwards positioning of arms to avoid attenuation is often difficult to hold in supine position and sometimes results in uncontrolled patient motion. This position is much better tolerated in prone decubitus, the patient head lying on folded arms in a more passive attitude. In our experience, only 5% of the patients could not tolerate this position. They were generally patients sent to the department for evaluation of cardiac risk by ^{201}Tl dipyridamole study before vascular surgery.

A possible drawback is the fact that most of the projections are acquired through the imaging table which introduces attenuation and scattered radiations resulting in an impairment of signal to noise ratio, and, thus, image quality, especially in redistribution studies. This problem is correctly solved when using a dose of 40 μCi per kilo. Besides this, we have designed a special imaging table with a taut cloth window facing the myocardium (Fig. 5) which suppresses attenuation for all projections. In addition, it allows a camera rotation in contour mode very close to the chest wall, close to 5 cm, resulting in high quality images.

Finally, another unexpected advantage has to be confirmed. In two patients, the prone study exhibited a small defect of the latero-apical wall not seen on the supine study. In both cases, the coronary arteriography confirmed the lesion by showing an occlusion of the distal left descending artery. We assume that prone position might improve resolution by minimizing the antero-posterior respiratory motion blur.

CONCLUSION

We conclude that prone myocardial tomography is a simple and efficient solution to the problem of inferior wall attenuation which was until now a limiting factor of ^{201}Tl tomography. Based on relevant anatomic considerations, it suppresses almost completely attenuation artifacts by removing the causes rather than correcting them. It also suppresses the effects of high individual variability in left phrenic and subphrenic anatomic configuration which makes correction methods difficult to design. It results in an important narrowing of the s.d. which should drastically improve specificity in the detection and evaluation of IW abnormalities. In addition, using a special imaging table results in images of high quality.

REFERENCES

1. Gordon DG, Pfisterer M, Williams R, Walaski S, Ashburn W. The effect of diaphragmatic attenuation on Tl-201 images. *Clin Nuc Med* 1979; 4:150–151.
2. Johnstone DE, Wackers FST, Berger HJ, et al. Effect of patient positioning on left lateral thallium-201 myocardial images. *J Nucl Med* 1979; 20:183–188.
3. Garcia EV, Van Train K, Maddahi J, et al. Quantification of rotational thallium-201 myocardial tomography. *J Nucl Med* 1985; 26:17–26.