

# COMBINED TRANSMISSION-EMISSION SCANNING USING DUAL-PHOTON ABSORPTIOMETRY

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A combined transmission-emission scanning method (DP-TES) combining dual-photon absorptiometry ( $^{153}\text{Gd}$ ) and conventional bone emission scanning ( $^{99\text{m}}\text{Tc}$  - MDP) was developed. Transmission scans provided the bone-mineral and soft-tissue thicknesses which were used to correct for the attenuation of emission photons by these tissues. A rectilinear scanner with scintillation detectors and focussed collimators was used. The transmission detector and source were offset from these detectors by 22 cm. This DP-TES method provided locational information for the visual interpretation of emission scans using either the soft-tissue or bone-mineral images. The DP-TES method also corrected the emission scan for attenuation and provided a quantitative uptake per unit bone mass.

The sources of error in dual-photon absorptiometry were studied. Corrections were developed and evaluated for deadtime, Compton-scattering, and beam-hardening. Partial volume errors were reduced by calibration of the transmission measurements using skeletons. The above corrections reduced the overall accuracy errors in total body bone-mineral and soft-tissue mass to about 3 and 2% respectively.

The emission scanning system was evaluated. The use of the geometric mean of the counts recorded in two opposed detectors provided a response which was essentially independent (3% variation) of source position within a constant-thickness water bath. The increase in resolution element of the emission detectors at points off the focal plane led to somewhat poorer emission images than usually are obtained clinically.

Combined transmission-emission measurements in vitro were made. The results on an emission source could be adequately corrected so that they were independent (within 1%) of the attenuation by water and aluminum at thicknesses up to 12 g/cm<sup>2</sup> and 3.6 g/cm<sup>2</sup> respectively. Two models for the correction of quantitative emission scans in vivo were developed. One model assumed a single source distribution (as in long bones) while the second assumed that the source was distributed at two loci (as in the trunk and head). The two-source model provided results which were independent (1% variation) of the separation of two sources in 12 cm of water over a range of separations from 2 to 10 cm. Cross-talk between the transmission and emission detectors was minimal due to the physical separation of the detectors. Transmission measurements both in vitro and in vivo gave results that were independent (1% variation) of the presence of  $^{99\text{m}}\text{Tc}$ .

The accuracy of the DP-TES method was difficult to assess in vivo in a direct manner. The largest source of error appeared related to the distribution of the source within the body. However the results of the two models in vitro indicated that if suitable models were obtained the corrected results would be accurate within 1-2%.

DP-TES scans were done on three subjects. The emitted source intensities were corrected by the DP-TES method and were increased by a factor of 2 to 3 from the uncorrected values. The increased values may provide improved contrast for lesions present in thick body sections. The relative  $^{99\text{m}}\text{Tc}$ -MDP uptake in body regions containing large amounts of trabecular bone was greater than that in regions containing predominantly cortical bone.

DP-TES scans could be done over more limited body regions of clinical interest (for example the lumbar spine). Such scans could provide highly accurate location information, as well as providing quantitative uptake, at a relatively low radiation dose.