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The Scintigraphic Sign for Detection of Right-to-Left Shunts

TO THE EDITOR: In a recent paper in the *Journal*, Dogan et al. reported on lung scintigraphies in patients with right-to-left shunts (*1*). They found a new scintigraphic pattern in extrapulmonary distribution after intravenous injection of ^{99m}Tc-labeled macroaggregated albumin in 18 of 49 patients with proven cardiac right-to-left shunt, a so-called "quantum mottling" pattern, visible in kidneys and brain. Dogan et al. argued that this phenomenon is caused by too few particles, which where 50,000 to 100,000 in each patient. The size of the shunt was >10%. Dogan et al. concluded that the quantum mottling pattern allows a reliable proof of a cardiac right-to-left shunt.

Between 1978 and 1991 we carried out more than 500 investigations in 150 children with tetralogy of Fallot and pulmonary atresia with ventricular septal defect. We injected 2 MBq/kg body weight (minimum activity, 15 MBq) of ^{99m}Tc-labeled macroaggregated albumin intravenously in the supine position (Solco^{R} MAA, Sorin Biomedica, Italy; in more than 95%, the particle size ranged between 5–40 μm, the number of particles comes to 2,000/MBq according to the producer). If there was a perceptible extrapulmonary activity in the perfusion scintigraphies, we proceeded on the assumption that the right-to-left shunt was measurable. That was the case in 71 children. The scintigraphic right-to-left shunt varied between 7% and 63%, the average was 27.5%. A preoperative cardiac catheterization was also performed and determined a ventricular septal defect in all children. Due to the fact that the whole extrapulmonary activity was not measurable at the same time, we used the accumulation of the radioactive tracer in the kidneys as a reference to the extrapulmonary activity. Assuming that the kidneys receive about 25% of the heart-time volume, we multiplied the activity in the kidneys by a factor of 4:

$$\text{Formula 1: } \frac{\text{Activity}_{(\text{kidneys})} * 4 * 100\%}{\text{Activity}_{(\text{kidneys})} * 4 + \text{Activity}_{(\text{Lungs})}}.$$

However, we found a homogeneous pattern of activity over the kidneys and brain in all children. Depending on the size of the shunt volume, there was a corresponding strong accumulation over the kidneys and brain, which was always homogeneous. There was no evidence of a quantum mottling pattern described by Dogan et al. (*1*). Also, Gates et al. who reported on 36 children with various congenital heart defects, could not find this phenomenon in their scintigraphies (*2*). The number of particles in our study was between 30,000 and 60,000 which is comparable to Dogan et al. Thus, the small number of particles does not sufficiently explain the quantum mottling. Possibly, the activity has not been shaken up immediately before the injection causing several macroaggregates to be linked together. This might have led to a larger size of the conglomerated particles and to a decrease in the total quantity. Although in children the absolute number of particles is smaller than in adults, the specific number of particles per volume is higher. Consequently, the scintigraphy in children might be more homogeneous, on the other hand there is no significant difference in perfusion concerning the homogeneity of brain and kidneys between children and adults. Also, a smaller shunt volume is not a sufficient explanation for the quantum mottling because even in children with a small shunt (10%–20%) there was no evidence for that phenomenon. Even though Palevsky et al. mentioned quantum mottling of the brain in two adults with a right-to-left shunt, many other authors did not find this phenomenon (*3*). However, in our opinion, a quantum mottling pattern in children does not exist as illustrated in Figure 1.

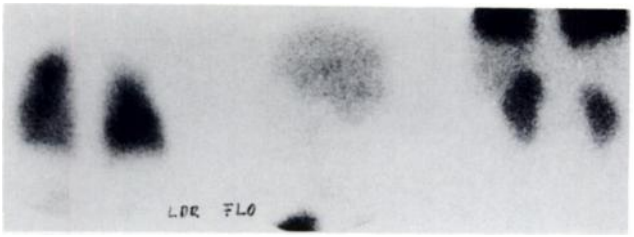

FIGURE 1. An 8-yr-old girl with a calculated right-to-left shunt of 25% shows a homogeneous distribution of activity over the brain and kidneys. Lack of activity in the thyroid demonstrates the absence of pertechnetate. For comparison of the relative distribution of radioactivity, the dorsal lung image is given. Activity used was 35 MBq with 70,000 particles.

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REPLY: We read with great interest the letter submitted to the *Journal* by Meins et al. regarding our recent article on the scintigraphic findings in patients with right-to-left shunts. We were surprised to hear that our colleagues from Hannover did not observe a quantum mottle (QM) pattern on ^{99m}Tc-MAA images obtained in patients with documented right-to-left shunts, and we were even more surprised by their suggestion that our reported finding was due to imaging artifacts or poor radiopharmaceutical preparation technique. Accepting the observations of our German colleagues, we decided to search for an explanation for the two discordant reports.

The question of imaging artifact or inappropriate radiopharmaceutical preparation was easily dismissed. In our department, all radiopharmaceutical preparations and evaluations are done under the close supervision of a board-certified radiopharmacist. Right-to-left shunt studies are done only with fresh preparations of ^{99m}Tc-MAA, and the contents of each newly prepared kit undergo meticulous quality assurance testing, including thin-layer chromatography and evaluation of particle size with a microscope and