The influence of scattered radiation on the dual-energy x-ray absorptiometry

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PURPOSE

Bone densitometry, also known as dual-energy x-ray absorptiometry (DXA), is a noninvasive diagnostic method capable of assessing the degree of bone mineralization of the skeleton or its segments through bone mineral density (BMD) and to estimate the body composition of lean and fat tissue of the individuals by body composition (BC). DXA equipment is based on the measurement of the attenuation difference between the two radiation beams after passage through the tissues. In nuclear medicine services across in Brazil it is possible to find a DXA in its dependencies without the need of shielding the room. Because it is not a high-energy, high-flux radiation emitter (high kV and mAs), the equipment may be close to free and supervised areas. During a research protocol aimed at studying the body composition of a control group, the influence of scattered radiation due to the reduction of fat tissue (TG) in relation to lean (TM) in the DXA results obtained was verified.

METHODS

The DXA used was Hologic Discovery with high-definition digital detectors, dual X-ray emission of 100 and 140 kV.

Tests were performed with point sources of 2.5 mCi of fluoride (F-18) and 2.2 mCi of technetium (Tc-99m) in the vicinity of the DXA room after office hours and during the routine, in the absence and presence of injected patients. Two weekly quality control tests were performed daily: body composition and small animal whole body composition. In both periods, the Hologic phantom (SH) and the Hologic animal (AH) were used. The first one simulates the lumbar spine, while the second one analyzes the difference between structures according to thickness.

Figure 1. Representation of the DXA equipment of the HOLOGIC Discovery brand present at the Nuclear Medicine Service of Hospital das Clínicas, UNICAMP.

RESULTS AND DISCUSSION

Due to the high patient demand, the DXA exams take place throughout the routine service hours. In routine tests, it was possible to verify a significant difference in body composition in the presence of Tc-99m sources in 13.12% and in 17.86% with F-18. During the routine, it was observed that with SH, in the absence and presence of injected patients, there was a maximum percentage difference of 1.35% in the BMC and 0.43% in the BMD in relation to the nominal values stipulated by the manufacturer. In the HA test, the maximum percentage difference was 11.41% in BMC and 7.27% in BMD. Regarding body composition, there was a 6.80% decrease in TG in relation to TM in the presence of patients injected with Tc-99m and F-18.

The tests, after and during the routine, were performed considering different spatial configurations of the sources. In addition, according to the number of patients injected, companions, disposition in the waiting room and radionuclide in use, a relevant difference was observed in the results obtained. In the presence of two patients injected with F-18 and four patients with Tc-99m, the percentage difference in body composition was about 10%.

Table 1 - Maximum difference obtained with the Spine Hologic phantom according to BMC and BMD parameters.

Phantom	Parameter	Maximum difference
SH	BMC (g)	1,35
	BMD (g/cm²)	0,43
AH	BMC (g)	11,41
	BMD (g/cm²)	7,27
	Fat (g)	7,01
	Lean+BMC (g)	14,22
	Total Mass (g)	0,66
	%Fat	6,80

CONCLUSION

As there is no dose administration to patients submitted to DXA, because it was an X-ray beam, it was possible to verify with the tests the interference of the radiation spread by Compton effect from the patients injected during the routine. Factors such as the number of patients and caregivers, their provision in the waiting room, the activity administered and the radiotracer administered influence the results obtained in the phantom acquisitions.

REFERENCES

BONNICK, Sydney Lou et al. Bone densitometry for technologists. Humana Press, 2006.

SORENSON, James A. et al. Physics in nuclear medicine. Philadelphia: Saunders, 1987.