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Development of a new skull phantom for calibrating in vivo measurements of Pb-210

The internal exposure dose estimation formula is E=I·e(g), where I is the intake, and e(g) is the dose coefficient. Therefore, the intake I directly determines the committed effective dose, and the main purpose of internal exposure monitoring is to obtain the value of the intake I by measuring the retention. In order to improve the accuracy of the intake I, a more effective measure is to calibrate the counter to improve the measurement accuracy of the retention. In this paper, a new anthropometric skull phantom has made for skull counter calibration, and carried out calibration of the skull counter.

The phantom's head circumference of is 56.18cm, the total head height is 23.31cm, the maximum head breadth is 15.76cm, and the maximum head length is 19.23cm. conforms to the reference Chinese male . The phantom consists of bone substitute and soft tissue substitute, the soft tissue substitute is polyurethane, and the hard bone substitute is a mixture of epoxy resin and calcium carbonate. At 46.5keV , the relative deviations between the mass attenuation coefficients of the two tissue equivalent materials and the reference values in the ICRP23 report are 0.86% and -2.98%, respectively. The relative deviation of the mass attenuation coefficient of brain tissue and soft tissue at 46.5KeV is 5.03%, so soft tissue substitute can be used instead of brain tissue. The phantom was made by pouring.

The mold is made by 3D printing.

In order to restore the bone-seeking nuclide distribution, the paper decided to use the point source to simulate the surface source by evenly distributing it on the skull surface. The solution of the radioactive source is dropped on the filter paper, and then the filter paper is cut and attached to the corresponding position of the skull, and the skull is suspended in the head mold. After the positioning is completed, soft substitute is poured and the radioactive source is sealed.. The radioactivity of the Pb-210 is 4203Bq.

The skull counter uses an electrically cooled HPGE. The measurement was carried out in a low-background laboratory. In order to ensure the consistency of multiple measurements, a limit device was designed for the phantom. The detector plane was close to the scalp during measurement. By 3 replicate measurements, the average detection efficiency was 0.00501 cph/Bq.

In this paper, an anthropometric skull phantom that conforms to the reference Chinese male is designed and manufactured. Using this model, the efficiency of the skull counter can be calibrated, so as to provide support for the accurate acquisition of Pb-210 retention.

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