

# **HDRK-MAN: A WHOLE BODY VOXEL MODEL BASED ON HIGH-RESOLUTION COLOR SLICE IMAGES OF A KOREAN ADULT MALE CADAVER**

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## **ABSTRACT**

This paper describes the construction of an adult male voxel model named ‘HRDK-Man,’ which was constructed using high-resolution color slice images from the serial sectioning of a 33-year-old Korean adult male cadaver.

**KEYWORDS:** Voxel model; Tomographic model; Monte Carlo; Dosimetry; Organ Dose

## **1. INTRODUCTION**

In this study, a voxel model called ‘HRDK-Man’ was constructed using the high-resolution color slice images from the Visual Korean Human (VKH) project [1]. The dimensions, including the body height and weight, skeletal mass, and individual organ and tissue masses, were adjusted to the Reference Korean data following the procedure used for the construction of Rex and Regina [2]. The developed model was then implemented in a general purpose Monte Carlo particle transport code, MCNPX [3], and used for the calculation of radiation doses to the organs and tissues.

## **2. MODEL DEVELOPMENT**

This study developed the voxel model using the VKH anatomical images obtained from the cadaver of a 33-year-old Korean male (164 cm, 55 kg). The cadaver was serially sectioned at 0.2 mm intervals and photographed with a high-resolution digital camera. A total of 8,590 photographic images were obtained for the whole body of the cadaver. The images were color images of very high resolution (0.1875 mm x 0.1875 mm).

In this study, the color anatomical images were selected for every 2 mm interval, so that 850 images were selected out of the total of 8,590. A total of 28 organs and tissues were segmented on the color anatomical images. After the segmentation, the resolution of the serially sectioned images was reduced to 1.875 mm x 1.875 mm in consideration of the computing speed and memory of the computers in use.

The height and skeletal mass was adjusted by scaling the voxel dimensions. Specifically, the height of the model (164 cm) was adjusted to the height of the Reference Korean (171 cm) simply by increasing the voxel size from 2 mm to 2.0854 mm in the z direction. The skeletal mass absent from the Reference Korean data was calculated based on the method suggested by Clays et al. [4], at 9.6 kg. The skeletal mass of the model was adjusted to 9.6 kg by adjusting the size of the voxels in the x-y-plane direction. The sizes of the organs and tissues were adjusted to the Reference Korean data by using the Inner Grow and Outer Grow functions of Photoshop7.0™. The Reference Asian data [5] were used for some organs for which the Reference Korean data were not available. After the adjustment of the height, skeletal mass, and the organ and tissue sizes, the weight of the model was 67.8 kg, 0.2 kg less than the weight of the Reference Korean (68 kg). The weight of the model was adjusted by adding 0.2 kg of adipose tissue to the surface of the legs.

### **3. RESULTS AND DISCUSSION**

In the present study, an adult male voxel model was constructed from high-resolution VKH color slice images. The developed model is 171 cm in height and 68 kg in weight. The size of the voxels is 1.981 x 1.981 x 2.0854 mm<sup>3</sup>. The size of the voxel array is 247 x 141 x 850 (29,602,950) in the x, y, and z directions, which corresponds to 489.307 mm, 279.321 mm, and 1,772.59 mm, respectively.

The developed model HDRK-Man was implemented in MCNPX to calculate the organ and tissue doses. The calculated values of those doses were found to be very reasonable when compared with the values from the other models considered in this study. In general, the differences among the organ and tissue doses were very small for the antero-posterior (AP) irradiation geometry. For the left-lateral (LLAT) geometry, the differences were somewhat larger, HDRK-Man showing higher doses than the other models in most of the cases, seemingly due to the fact that the arms of VKH-Man are shifted backward.

### **4. CONCLUSIONS**

In the present study, an adult Korean male voxel model was constructed using the high-resolution color slice images from the VKH project. The model was adjusted to the Reference Korean data to develop a model that represents an average Korean worker. The calculation

results show that the developed model provides very reasonable dose values when compared with the other models considered in this study.

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