

IMPLEMENTATION OF SALIVARY GLANDS IN THE BODYBUILDER ANTHROPOMORPHIC PHANTOMS

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ABSTRACT

We describe the modeling of salivary glands as implemented in the BodyBuilder program. It generates anthropomorphic phantoms for use in an MCNP input file. The models are oriented with the Z axis as vertical and the positive Y axis in the posterior direction. From the outside in, the lower part of the head consists of skin, an undifferentiated tissue layer, the jawbone, and more tissue. These layers are bounded, in part, by concentric and congruent elliptical cylinders centered on the Z axis at $X = Y = 0$. The jawbone extends from the mid-plane ($Y = 0$) of the head forward. The salivary glands are modeled as left/right pairs.

The sublingual glands are bounded by two cylinders in the Y direction that are tangent at $X = 0$. The Z value for their centers is the top of the spine. The cylinders are cut off by the inner jawbone surface and a plane perpendicular to the cylinders chosen to give an approximate length of 2 cm. The dimensions cited are for the male adult model before adjustments to match volumes. The submandibular glands are centered in the Z direction on the lower edge of the jawbone and are approximately 2 cm thick in that direction. The other surfaces bounding the submandibular glands are an elliptical cylinder congruent to the elliptical cylinder of the inner jawbone surface but with radii 2 cm smaller and planes at $Y = -2$ cm, $Y = -5.5$ cm, and $X = \pm 1.8$ cm. Each of the parotid glands consists of two parts. The inner part lies between the two elliptical cylinders that bound the jawbone. It is bounded in front by the rear edge of the jawbone and in the rear by a plane at $Y = 1.5$ cm. The bottom is coincident with the lower edge of the jawbone. The height is 4 cm. The outer parts of the parotid glands lie between the elliptical Z cylinders for the inner skin and outer jawbone surfaces and an elliptical cylinder parallel to the X axis. The center of the latter cylinder is 2 cm above the lower edge of the jawbone in the Z direction and at $Y = 0$. The radii are 2.3 cm (Z direction) and 2 cm (Y direction).

We calculated the volumes of the modeled salivary glands using the volume fraction feature of the Moritz program. We then adjusted some of the dimensions to match the volumes given by ICRP 89. In addition to the adult male, BodyBuilder generates models at ages between 1 year and adult and a newborn model. As a first approximation to accommodate the smaller head sizes of these models, we multiplied the dimensions of the salivary glands by the ratio of the semi-major radius of the outer jawbone elliptical cylinder for the current age to the value of the adult radius. We calculated the volumes and adjusted the dimensions to match ICRP 89 as for

the adult model. The procedure was performed for the newborn and 1-, 5-, 10-, and 15-year old models (BodyBuilder interpolates between these models for other ages).

As for other organs available in BodyBuilder, the salivary glands can be included in the geometry or not. The user can choose to treat each of the three glands as separate left and right cells or as a combined left + right cell. In either case, the parotid, submandibular, and sublingual glands are distinct cells.