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Canine Torso Attenuation from Elbows Treated with Synovetin OA (Sn-117m)

Synovetin OA™ is used to treated dogs with osteoarthritic elbows by radiosynoviorthesis. Synovetin OA is a tin-117m colloid and the internal conversion and Auger electrons emitted by the tin-117m provide the therapeutic effect. Tin-117m also emits gamma rays, the highest energy of which is 158.56 keV. The external radiation field around a treated dog is of interest in order to limit the dose the owners/caretakers of the dog.

Canine anatomy is such that the dog's elbows are approximately at the same height as the lower extent of the dog's torso when in a standing position. In this position, the dog's torso attenuates the radiation being emitted towards the opposite side of the dog's body, above the dog, and towards the dog's posterior. In a seated position, this shielding effect is increased. This leads to a radiation field which is significantly non-isotropic. This study was conducted to establish the characteristics of this non-isotropic field.

A population of dogs of various sizes that could be injected with Synovetin OA was not available for various reasons. Therefore, in order to approximate the torso shielding effects from treated elbows, tin-117m sources were secured to the medial surface of the dog elbows and radiation field measurements were obtained. The tin-117m sources consisted of tin-iodide solutions absorbed on blotter paper and double-bagged in plastic Ziploc-type pouches for contamination control. The active area of the blotter paper was approximately 1 cm by 2 cm with total activities of 3.39 and 3.37 mCi each, about 10% more than the maximum prescribed activity per elbow. Figure 1 shows a dog with the sources taped to its elbows. Positioning of the sources in this manner is considered to be a good approximation for determining the radiation field at distances other than on contact.

10 dogs were selected for this study with sizes ranging from 11 pounds up to 85 lb. On each dog, up to 18 measurements were taken. Measurements were taken anterior, posterior, left lateral, and right lateral; at distances of 1 foot and 1 meter; and at the dog's elbow height and upwards at an angle of 45 degrees. This angle at a distance of 1 meter simulates the radiation field at the height of the torso of a person standing next to a dog. In addition, dorsal measurements were also taken at the 1 foot and 1 meter distances. The measurement locations are listed in table 1.

For all but the smallest dogs in the study, a distance of 1 foot anteriorly is under or within the dog's torso. Therefore, the 1 foot anterior measurements were taken at the dog's rump regardless of the distance from the rump to the elbow. The 1 foot dorsal measurement was taken on top of the dog's shoulders if this distance was 1 foot or more. The 1 foot upper anterior measurement was not made if it fell within the torso, in which case the doserate was assumed to be the same as for the 1 foot dorsal measurement (shown in red in table 2).

Table 1. Measurement locations

1 ft distance	1 meter distance
Anterior @ elbow height	Anterior @ elbow height
Left lateral @ elbow height	Left lateral @ elbow height
Right lateral @ elbow height	Right lateral @ elbow height
Posterior (on rump)	Posterior
Upper anterior	Upper anterior
Upper left lateral	Upper left lateral
Upper right lateral	Upper right lateral
Upper posterior	Upper posterior
Dorsal	Dorsal

Figure 1. Dog with sources secured to elbows.

Doserate measurements were made with a Ludlum 9DP ion chamber and with a Bicron µrem. However, the lack of precision in the analog scale on the Bicron was determined to not allow precise enough measurements to be made and therefore that data was rejected. A 1 meter fiberglass batten was used to ensure repeatability of 1 meter measurements and a fiberglass rod marked at 1 foot was likewise used for those measurements.

Table 2 provides the raw data from the measurements including the weight and breed of each dog used in the study. The average doserate at each distance was divided by the maximum doserate at that distance to determine an average effective shielding percentage provided by the dog's torso. A scatter plot of the results is presented in figure 2. Attachment A shows example doserate measurements.

Table 2. Survey Data, mR/hr (background doserate 0.003 mR/hr)

Weight (lb)	11	13	16	26	43	50	68	74	78	85
Breed	Dachsund	Dachsund	Terrier mix	Poodle mix	English bulldog	Border Collie	Pit bull/ Catahoula mix	Golden Retriever Mix	Chocolate Lab	Chocolate Lab
1m										
anterior	0.45	0.32	0.48	0.39	0.52	0.27	0.32	0.36	0.45	0.29
left lat	0.30	0.31	0.28	0.38	0.33	0.30	0.27	0.34	0.28	0.24
right lat	0.25	0.31	0.31	0.17	0.20	0.37	0.26	0.21	0.20	0.43
posterior	0.25	0.16	0.14	0.33	0.13	0.20	0.25	0.34	0.25	0.14
upper anterior	0.22	0.20	0.25	0.22	0.42	0.17	0.16	0.19	0.34	0.13
upper left lat	0.43	0.33	0.28	0.27	0.23	0.25	0.32	0.35	0.27	0.20
upper rt lat	0.30	0.41	0.28	0.28	0.17	0.40	0.31	0.17	0.29	0.30
upper posterior	0.32	0.26	0.16	0.29	0.15	0.28	0.08	0.09	0.07	0.08
dorsal	0.27	0.28	0.21	0.22	0.13	0.15	0.12	0.14	0.12	0.12
1 m max	0.447	0.407	0.477	0.387	0.517	0.397	0.317	0.357	0.447	0.427
1 m average	0.307	0.284	0.263	0.280	0.250	0.263	0.229	0.240	0.249	0.211
1 m Shielding reduction	31%	30%	45%	28%	52%	34%	28%	33%	44%	50%
1 ft										
anterior	1.6	1.36	2.8	2.6	2.3	0.94	1.3	2.1	2	1.5
left lat	0.8	1.8	1.3	2.1	1.5	1.3	1.6	1.5	1.3	1.1
right lat	1.4	2.16	1.6	1.5	0.95	2.1	1.2	1.05	0.84	2
posterior	2.1	0.5	0.5	0.43	0.3	0.45	0.15	0.26	0.35	0.16
upper anterior	0.8	1.4	1.8	1.6	1.5	0.84	1	1.1	1.5	1.2
upper left lat	2.3	1.6	1.4	1.6	1.6	1.2	1.4	1.9	1.3	0.84
upper rt lat	1.5	1.9	1.2	1.2	0.78	1.7	1	0.64	0.79	1.8
upper posterior	1.6	1.2	2.8	2.5	0.73	0.53	0.8	0.16	0.17	0.47
dorsal	1.6	0.85	2.8	2.5	0.73	0.53	0.8	0.16	0.17	0.47
1 ft max	2.297	2.157	2.797	2.597	2.297	2.097	1.597	2.097	1.997	1.997
1 ft average	1.519	1.416	1.797	1.778	1.151	1.063	1.025	0.983	0.933	1.057
1 ft Shielding reduction	34%	34%	36%	32%	50%	49%	36%	53%	53%	47%

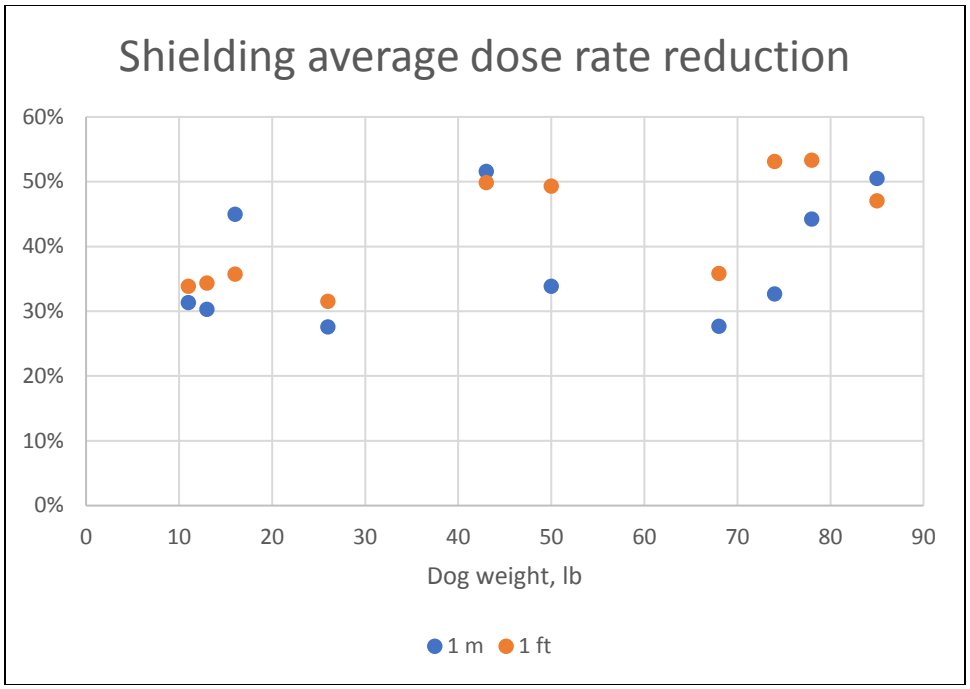

Figure 2.

The average 1 meter shielding effectiveness is a 37% reduction with a minimum reduction of 28%. The average 1 foot shielding effectiveness is a 42% reduction with a minimum reduction of 32%. The trendline for the percentage of effective shielding trends upward with increasing dog size although there is significant variability. This variability is attributed to the positioning of the tin-117m sources on the medial surface of the elbow rather than it being injected into the elbow which can result in streaming around the elbow for geometries other than anterior. However, for purposes of radiation safety, the results are still useful.

It is recommended that for the purposes of radiation safety, an average 1 foot shielding effectiveness of 32% and an average 1 meter shielding effectiveness of 28% be used.

Attachment A
Doserate measurement pictures