Radioisotopic Localization in Subdural Hematomas

An Experimental Study with Arsenic-74 and Radioiodinated Human Serum Albumin in Dogs*

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POSITRON-EMITTING arsenic-74 and I$^{31}$-labeled human serum albumin (RISA) have been used extensively in brain scanning over the past 10 years. Although the experience with radioactive techniques in the diagnosis of subdural hematomas remains relatively limited, unilateral lesions have been localized successfully and fairly consistently with either isotope.$^{2,3,9,11}$

The causes of an increased concentration or counting rate over some subdural hematomas which in turn permits detection of these lesions by scanning has not been defined clearly. Relevant information from radioassay of human biopsy samples and other studies is incomplete, with no data available on the uptake of either isotope in the brain under the subdural hematomas.

For arsenic-74, Sweet et al.$^{11}$ found that the clot and fluid hematoma which made up the major bulk of the subdural hematomas of 5 patients took up no more, and often less, of this isotope than did normal brain samples from other individuals. The outer subdural membranes contained about three times this amount.

Similar studies by Dunbar and Ray$^{2}$ with RISA showed that the subdural fluid of 4 patients contained much less of this substance than was found in venous blood. They suggested that the hematoma caused alterations in the vascularity of the brain that permitted “leakage” of additional isotope into the entire ipsilateral hemisphere. These findings were confirmed more recently by Feindel et al.,$^{3}$ who likewise wondered what contribution, if any, the brain immediately subjacent the subdural hematoma made to the increased activity noted over these lesions in the scans. With RISA also, biopsy samples of membranes can contain more activity than the fluid hematoma and clot.$^{7}$

This is a report on observations of the differential qualitative and quantitative uptakes of arsenic-74 and RISA in experimental subdural hematomas and adjacent tissues of dogs. These studies agree with and augment analogous results available from human biopsy samples and elucidate more fully the nature and magnitude of the uptake of these isotopes in and about subdural hematomas.

Methods

Twenty female mongrel dogs, 8–16 kg. in weight (average, 11 kg.), with experimental subdural hematomas were included in this study. The surgical techniques, the gross anatomical and histological characteristics of the lesions, and the results of these investigations in a larger group of animals were presented elsewhere.$^{5}$ Thirteen animals were given sodium arsenate (arsenic-74)$^{†}$ and 7 animals received RISA.$^{*}$ The intervals between intravenous injection of the isotopes and sacrifice of the animals were chosen to correspond more or less with intervals frequently used clinically in brain scanning. One dog (No. 38) died 1–20 hours after injection from a cause not related directly to the subdural hematoma. With this single exception, a standard method of sacrifice was used in all animals. After administration of pentobarbital (26 mg./kg.) intravenously the femoral arteries were cannulated and the animals were allowed to exsanguinate.

The brains were removed immediately after death with the dura mater intact over the cerebral hemispheres. The fresh specimens were rinsed with saline and studied prior to fixation or freezing. Coronal slabs (3–5 mm. thickness) were cut from the frozen brains of 8 animals and were placed on Eastman Kodak “no screen” roentgen-ray film in a deep freezer for radioautography. From all animals, multiple samples were taken of the subdural hematoma, the adhering dura

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mater, and the subjacent cerebral cortex with a variable minimal amount of contiguous convolun-
tional white matter included. Two cortical sam-
ple were taken from under each corre-
sponding sample of hematoma, stripping the pia-
arachnoid layer off one of the pair in each in-
stance. In the same coronal plane on the normal
side matching samples of dura mater and cortex
with and without the pia-arachnoid investment
were selected. Although the majority of the sam-

All sampling was performed in a standard man-
ner on fresh or thawed, well-blotted tissues by
the author, taking care to prevent losses by dry-
ing. The samples were wet-weighed immediately
on waxed celluloid and then frozen rapidly for
quantitative transfer into test tubes for counting.

Radioactivity was measured in all samples in a
standard well counter with a sodium iodide crystal
and decade scaler. In every series of determina-
tions known standard dilutions of arsenic-74 or
RISA given the animals were counted with the
samples. As the physical decay of the samples and
that of the standard were equal, the computa-

of radioactivity in the samples reflect only bio-
ological processes. Tissue concentrations are ex-
pressed here as per cent of dose per gm. or ml. of
sample and are multiplied by 1000. Tissue con-
centrations expressed in this manner are conven-
iently comparable despite a wide variation in total
injected activity of arsenic-74 or RISA in different
animals in this study.

Results

A. Radioautography. Figs. 1 and 2 show
coronial sections and corresponding radio-
atographs from the brains of 2 of the 4 ani-

Fig. 2. Dog 380. Frozen coronal section showing a
residual subdural membrane on the left. Below is the

Fig. 1. Dog 375. Frozen coronal section of brain show-
ing a subdural hematoma. Below is the corresponding
radioautograph with arsenic-74 (dose 80 µc./kg., and
exposure 48 hrs.).

Fig. ~. ~ was
375.

Differences in concentration between similar
areas of the brain subjacent the subdural
hematomas and in the normal hemisphere
are not apparent. In Fig. 1, the subdural
hematoma, 10 days old, has taken up the
isotope in a patchy manner, with higher con-