GAMMA-RAY IMAGE OF SUBDURAL EFFUSIONS
SCANNING AFTER INJECTION OF RADIO-IODINATED SERUM ALBUMIN INTO SUBDURAL SPACE AND ITS CLINICAL APPLICATION*

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The distribution and turnover of radioiodinated (I\(^{131}\)) human serum albumin (RISA) has been studied in the plasma, cerebrospinal fluid, and collections of subdural fluid in infants and adults. From experimental observations, an external scanning technique has been developed to delineate accurately the anatomic proportions of previously known nonacute subdural effusions. Rather than giving RISA intravenously in relatively large doses, much smaller quantities of the labeled albumin are injected percutaneously into the subdural space, before scanning the head. This method of evaluating collections of subdural fluid is most useful in the traumatic and postmeningitic subdural effusions that occur in infants and small children. It probably also has some application in the postoperative assessment of reaccumulations of subdural fluid in adults. Information on the character of the subdural effusions as visualized in the scan has been correlated with subsequent clinical observations. From these preliminary studies, it is postulated that this radioactive technique will prove helpful as a surgical guide in infants with subdural effusions who come to operation. In addition, this method of scanning may yield in the treatment of these infants more clear-cut indications for and against either craniotomy or continuing further a series of subdural taps.

EXPERIMENTAL RATIONALE

The abnormal uptakes when noted in the scans of adults with subdural hematomas, after intravenous injection of 400–500 \(\mu\)g of RISA, usually are not seen clearly enough for precise anatomic delineation of the lesion. Scanning has not been used to any extent to detect subdural hematomas in infants and children. The lack of optimal definition of subdural hematomas in adults by scanning after intravenous injection of RISA, which probably also would be the case in infants, is because of the lower uptake of the labeled albumin in the subdural lesion as compared to the plasma. Also, the sustained high level of gamma radiation from the RISA in the plasma gives rise to a troublesome masking effect on the scan. These differences, 26 hours after intravenous injection, in the relative concentration of RISA in the plasma and subdural hematoma of an adult and an infant are shown in Table 1. H.S. had a classical lesion and was studied 3 months after known trauma. The activity of the fluid and clot of his subdural hematoma was only 7.6 and 1.9 per cent, respectively, of the activity measured in his plasma; the well-developed outer membrane had less than half as much activity per ml. as did the plasma. Activity in the inner membrane could not be measured above the background counts. Similarly, in the infant, L.B., with a traumatic subdural

<table>
<thead>
<tr>
<th>Sample</th>
<th>Ratio: Subdural Sample to Plasma, at 26 Hours</th>
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<tbody>
<tr>
<td></td>
<td>Adult (H.S.)</td>
</tr>
<tr>
<td>Subdural fluid</td>
<td>0.070</td>
</tr>
<tr>
<td>Subdural clot</td>
<td>0.019</td>
</tr>
<tr>
<td>Outer subdural membrane</td>
<td>0.48</td>
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* Per cent of dose per ml. of sample.
effusion, samples of the bloody and xanthochromic subdural fluid contained only 11 per cent of the activity of RISA that was determined in the plasma.

In contrast, when RISA is injected into the subdural space, the ratio of activity of the labeled albumin relative to the plasma becomes very large. This is shown in Fig. 1, in the case of an infant, W.P., who received an injection of 20 µc of RISA into a traumatic left-sided subdural effusion. Thereafter, subdural fluid was removed in about 1 ml. amounts on only 3 occasions over the 5-day period of study to minimize changes of the volume of the hematoma. The data have been corrected for losses of injected activity incident to sampling. From these measurements, at 24 hours, the ratio of the concentration of RISA in subdural fluid to that in the plasma is about 150. In addition to the induced effect of different methods of administration, these differences in the concentration of RISA in plasma and subdural fluid, depending on whether the labeled albumin is given intravenously or into the subdural space, are related to the higher content of protein in the plasma and the dynamics of exchange of albumin across semipermeable membranes. The tenacious persistence of the labeled albumin in the subdural fluid after direct injection, and the resulting low levels of activity of plasma provide a pathophysiological mechanism to facilitate better definition of the subdural effusions by external scanning of the gamma radiation from the head.

The dose of radiation to the patients incident to these clinical and experimental investigations with RISA has been measured and is within acceptable levels. It has been calculated¹⁰ for a 7-kg. infant who receives 20 µc of RISA in the subdural space that the total dose of beta and gamma radiation to the brain and whole body is less than the dose attending many routine radiographic procedures requiring 4 to 7 roentgenograms of the skull. In these calculations, the effective half life of RISA, determined experimentally in subdural fluid and in the general circulation, was used; it was assumed that no extraordinary losses of total injected activity occurred. However, in practice, by the simple expedient of a subdural tap after the scan is performed, much of the injected dose can still be recovered from the subdural fluid. For example, in Fig. 1, a 10-ml. subdural tap in this infant, after he was scanned at 24 hours, would remove about 50 per cent of the total injected activity of RISA. This tactic reduces markedly the over-all local and whole-body dose of radiation to the patients under study, and can permit bilateral scans, when indicated, within a few days in the same individual.

METHODS

The patients received a solution of radiiodinated (I¹³¹) human serum albumin (RISA), available commercially from Abbot Laboratories. Lugol’s potassium-iodide solution was given the day before in the more recent studies to block the thyroid gland. Subdural injections were performed percutaneously, lateral to the anterior fontanelles in infants, and through burr holes in adults. The solution of RISA was barbotaged with the subdural fluid to distribute the isotope uniformly.

The subdural doses of RISA in the infants ranged from 13.3–22.5 µc. In one infant with an extremely large subdural hematoma it was necessary to repeat the scan with a larger dose (50 µc) to obtain better resolution. A dose of 40–50 µc gave excellent contrast in the subdural scans of an adult.

On the day after RISA was injected into the