THE EFFECT OF EXPERIMENTAL CEREBRAL CONCUSSION ON THE BLOOD VOLUME AND THE PATTERN OF DISTRIBUTION OF RADIOACTIVE CHROMIUM-51 TAGGED RED BLOOD CELLS*

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In previous studies we have reported on the volumetric changes that occur in man following cerebral trauma. Because of the inherent nature of the problem, adequate clinical controls could not be obtained. This study is an effort to supply the experimental controls which seemed necessary.

In addition, our previous observations of patients with craniocerebral injuries, when radioactive iodinated human serum albumin and chromium-51 tagged red blood cells were used, indicated that in 80 per cent of these there was an alteration in blood volume from the calculated normal levels. In those cases in which cerebral trauma clinically appeared to be of a more severe degree, there was a progressive loss of red-cell mass and a blood-volume increase. There developed also an anemia as a result of these two physiological changes. In order to obtain more precise information as to what may be occurring in the physiological milieu during concussion, we thought it worth while to get a visual representation of the red-cell distribution under controlled conditions.

This paper is a summary of the blood volume and of the red-cell distribution in experimentally produced concussion as determined with radioactive chromium-51 tagged cells. This pattern (profile) of the red-cell mass, specifically of the spleen and the splanchnic area, was obtained by means of an improved scanning device.

MATERIALS

Twenty-two healthy mongrel dogs, weighing from 10 to 15 kg., were selected as the experimental animals. Six of these animals served as controls. Another group of 16 dogs was exposed to cerebral concussion.

Blood-volume determinations were made by utilizing the animal's own red blood cells, which were tagged with radioactive chromium-51 according to a previously described technique.6

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Serial hematocrit determinations were done on each animal. We employed both the centrifuge-tube packed red cell and the microhematocrit methods.

A radiosensitive scanner was adapted to these experiments for the purpose of determining the distribution of radioactive red cells within the abdominal cavity. With the animal placed in a fixed position under the scanning device, an area overlying the abdominal cavity was surveyed by a radiosensitive sodium iodide crystal. This crystal was passed mechanically over a selected body area at a fixed distance and rate for each experimental animal. The gamma radiations emitted from the tagged red blood cells within the animal’s body were then converted into electrical impulses at a fixed coefficient of radiation energy. The electrical energy developed was transmitted to a writing arm which passed at the same rate and distance over an electrically sensitive paper. With each impulse, the electrical contact between the writing arm and paper resulted in a fine perforation of the paper. Thus, a “profile” of the distribution of radioactive red blood cells within this portion of the animal’s body was obtained.

**TECHNIQUE**

Control observations were made on 6 animals. These consisted of (1) daily blood-volume determinations, (2) daily hematocrit determinations and (3) a daily scan profile of the fixed portion of the abdominal area. All these determinations were repeated at 24-hour intervals for 5 days. All determinations were carried out under intravenous Nembutal anesthesia in quantities of 20 mg. per kg. of body weight.

A second group of 16 animals was subjected to cerebral concussion. These animals were also under light Nembutal anesthesia. Pulse, respiration, blood pressure, blood-volume determinations, hematocrit and abdominal scan profiles were obtained the day before concussion and repeated immediately before the actual cerebral concussion. This gave control data.

The experimental cerebral concussion was produced by one of the following methods: (A) Multiple blows to the head with a 16-oz. hammer. (B) The electrical detonation of a DuPont #6 blasting cap taped to the surface of the animal’s scalp as described by Govons et al. A continuous record of the animal’s respirations, pulse and blood-pressure levels was obtained by the use of a Sanborn Twin-Viso apparatus.

The criteria of concussion were those suggested by Denny-Brown and Russell, viz. (1) transient abolition of the corneal reflex, or (2) period of apnea or of respiratory irregularity, (3) sharp rise in blood pressure immediately following the blow and (4) tachycardia.

The blood volume, hematocrit and body scans were repeated immediately following concussion and then at 24 hour intervals for a 3- to 5-day period.

Between determinations the animal was maintained in a cage with adequate standard nutritional care.