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of the beam inside the head by use of a radioactive beam. This will make it feasible to stop the beam accurately at the appropriate depth in the central nervous system in the head. Carbon-11 ion beams, for example, provide the potential of accurate positioning not available with helium or protons. Tobias and Chatterjee demonstrated that radioactive carbon-11 nuclei comprise about 1% of the total carbon-ion beam, emitting positrons with a half-life of 20.5 min. These positrons are detected with a specially constructed gamma camera. Recent studies have made it possible to form a small beam of pure carbon-11 particles which permit determination of the stopping points in an absorber with an accuracy of 1 mm. In one possible scheme for delivering focal lesions in the brain via radioactive heavy particle beams, the positron camera would continually monitor the precise location of the stopping points of the beam in the patient's head. The data would be fed back on-line to a variable absorber controlling the range penetration of the beam, thereby fully controlling the location and depth dose of the carbon beam.

PITUITARY IRRADIATION PROGRAM

John A. Linfoot, Peter Linfoot, Jacob I. Fabrikant, Jeanette Nakagawa, and Tokuko Saito

The alpha particle pituitary irradiation program continues to be a major research project at Donner Pavilion. A study to determine the incidence of hyperprolactinemia in a large series of acromegalic subjects was undertaken. The relationships between plasma levels of growth hormone and prolactin, sellar volume, duration of acromegaly, and age at time of evaluation were investigated.

An examination of 179 acromegalic patients revealed a high incidence of hyperprolactinemia representing either mixed or multiple pituitary tumors. Prolactin determinations were made on fasting plasma samples previously assayed for growth hormone. Results indicated a 40% incidence of hyperprolactinemia in this series. Patients are divided into two groups: Those without prior treatment and those having had unsuccessful prior surgery. The expected positive correlation between sellar volume, as defined by di Chiro and Nelson,[1] and growth hormone was observed. Sellar volume and prolactin did not correlate well, nor was there a relationship between prolactin and growth hormone. There was a negative correlation for both prolactin and growth hormone in the nonsurgical patients. Duration of disease had little relationship to hormone levels. The mean prolactin levels for nonsurgical males was 15.85 ng/ml compared to 27.54 ng/ml for nonsurgical females. Mean prolactin values for the surgical group were 23.44 ng/ml and 17.78 ng/ml for males and females, respectively. Differences in prolactin values between nonsurgical and surgical groups were insignificant (see Table 1). We concluded that: (1) The incidence of mixed tumors in acromegaly, as evidenced by hyperprolactinemia, is the same for males and females. (2) The incidence of hyperprolactinemia is not higher in patients who have undergone prior surgery. (3) There is no correlation between sellar size and the presence or absence of hyperprolactinemia. (4) The volume of the sella containing mixed or multiple tumors is correlated to the growth hormone level rather than to the prolactin level in acromegalic patients.

The follow-up of these patients to determine

Table 1 Statistical analysis of clinical parameters in 179 acromegalic patients to determine incidence and relationship of hyperprolactinemia prior to treatment with alpha particle pituitary irradiation

	Nonsurgical (NS)		Surgical (S)	
N	males (78)	females (60)	males (26)	females (15)
log GH:volume	0.45 ($p < 0.001$)	0.33 ($p < 0.01$)	0.38 ($p < 0.052$)	0.42 (ns)
log PRL:volume	−0.08 (ns)	0.29 (ns)	0.27 (ns)	0.09 (ns)
log PRL:log GH	0.16 (ns)	−0.08 (ns)	0.07 (ns)	−0.26 (ns)
log GH:age	−0.19 (ns)	−0.22 (ns)	0.15 (ns)	0.26 (ns)
log PRL:age	−0.28 ($p < 0.025$)	−0.27 ($p < 0.05$)	0.48 ($p < 0.015$)	0.45 (ns)
log GH:duration	0.08 (ns)	−0.06 (ns)	−0.11 (ns)	−0.10 (ns)
log PRL:duration	−0.08 (ns)	−0.38 ($p < 0.005$)	0.24 (ns)	−0.46 (ns)

ns = $p > 0.05$

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the long-term benefits and side effects of pituitary irradiation continues to be of major research interest.

REFERENCE

1. Di Chiro, G. and Nelson, K. B. 1962. "The volume of the sella turcica." *Amer. J. Roent. Radium Therapy and Nucl. Med.* 87:989-1007.

RECENT ADVANCES IN PITUITARY RESEARCH

John A. Linfoot and John T. Lyman

It has been previously determined that the low Bragg-peak-to-plateau ratio of helium ions[1] largely eliminates helium ions as a source of Bragg-peak high energy radiation necessary for rapid destruction of normal pituitary tissue in man. Heavy ions available at the Bevalac, however, such as carbon (^{12}C) and neon (^{20}Ne), have this potential biological advantage.[2] Using heavy ions and the Bragg peak, single or multiple laminar lesions or larger lesions using the spread peak should produce focal or total destruction of normal or abnormal pituitary tissue because of this radiation's high relative biological effectiveness (RBE). The spatial localization of hormone secreting cells within the pituitary of primates[3] and man[4] offers a physiological parameter to determine the effects of localized radiation on the pituitary *in vivo*.

While 910 MeV helium ions have been highly successful in treating hormone-secreting pituitary tumors, e.g., those associated with acromegaly.

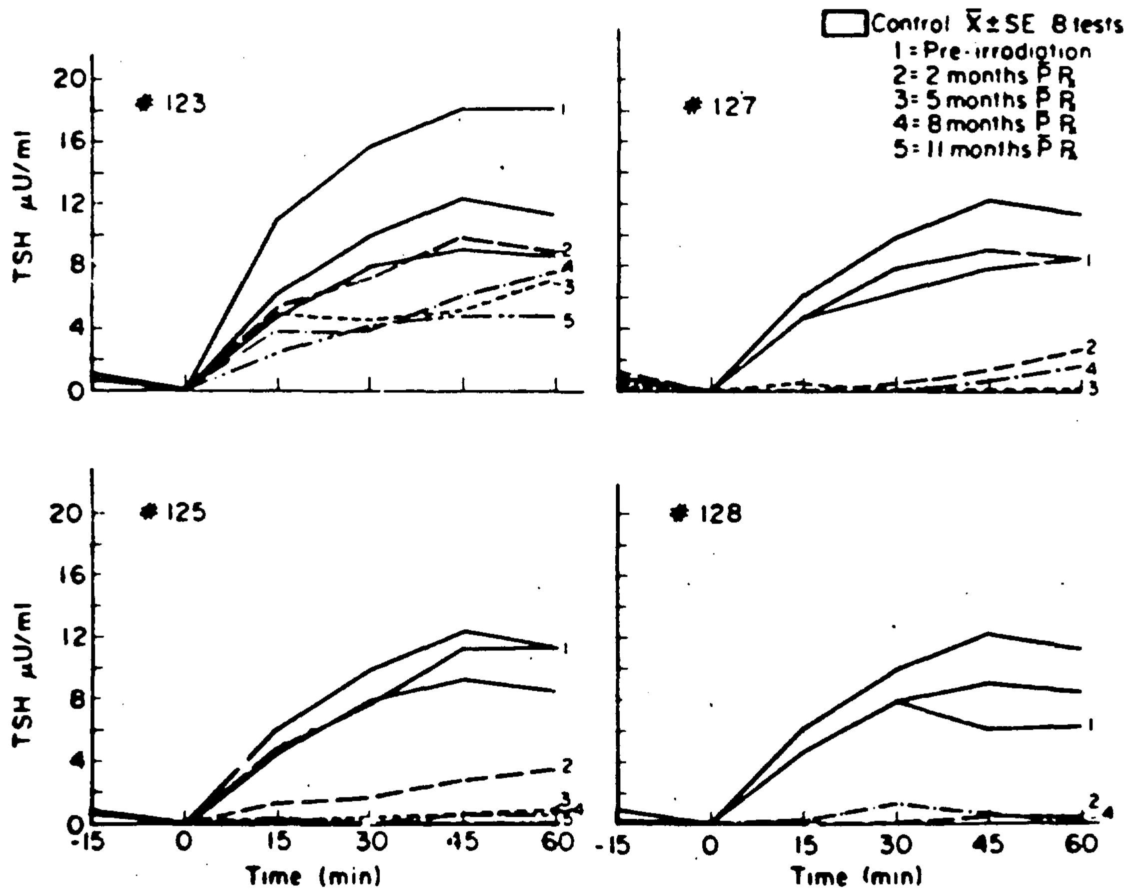

Figure 1. Changes in mean maximum thyroid-stimulating hormone (TSH) responses in Cynomolgus monkeys before and after 250 MeV/amu ^{12}C irradiation of the pituitary. Pharmacological stimulation of the pituitary peptide was produced using thyroid-releasing hormone (TRH) administered by rapid intravenous injection. XBL 806-3376