Hormonal Modulation of Pineal Melatonin Synthesis in Rats and Syrian Hamsters: Effects of Adrenalectomy and Corticosteroid Implants

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Summary

Pineal levels of tryptophan, 5-hydroxytryptophan, serotonin, N-acetylserotonin, melatonin, 5-hydroxyindoleacetic acid and the activities of the enzymes N-acetyltransferase and hydroxyindole-O-methyltransferase were determined in male albino rats and Syrian hamsters that were implanted with the appropriate corticosteroid or adrenalectomized two weeks earlier. Melatonin content and NAT activity were increased at 4 hours (during darkness) in adrenalectomized hamsters; conversely, no alterations in melatonin levels were observed in either adrenalectomized or implanted rats. It is suggested that the changes in adrenal function probably have a minor influence on pineal melatonin production.

Key words: Pineal, melatonin, corticosterone, cortisol, adrenalectomy.

Introduction

The role of the adrenal glucocorticoids in pineal indoleamine synthesis has been investigated sparingly. Cortisol or corticosterone injections had no effect on the number of granules present in pinealocytes (Clementi et al., 1962), the pineal serotonin (5-HT) rhythm
(Cagnoni et al., 1966) or N-acetyltransferase (NAT) activity (Illnerova, 1976). However, in a rat pineal cell culture, cortisol increased aryl sulphatase activity without affecting other enzymes within the primary metabolic pathways (Milcu et al., 1968). Also, cortisol decreased bovine pineal monoamine oxidase (MAO) activity slightly and increased melatonin synthesis, although the data for these findings are not supplied (Urry et al., 1976).

Alterations in pineal indoleamine metabolism have been observed after adrenalectomy. However, separate studies have found opposite effects in virtually every biochemical parameter measured to date. For example, Sugden and Klein (1983) saw no effect of adrenalectomy or hypophysectomy on pineal hydroxyindole-O-methyltransferase (HIOMT) activity in neonatal or adult rats while Deussen-Schmitter and colleagues (1976) observed an increase in pineal HIOMT activity in adrenalectomized rats. Likewise, contrary findings have also been reported in reference to NAT activity in adrenalectomized rats; Reiter and his coworkers (1982) observed a depression in both NAT activity and melatonin content at 2 hours in adrenalectomized rats. Lynch et al. (1977) on the other hand, found no effect of adrenal removal on NAT activity.

Recent findings indicate a role for the glucocorticoids in pineal melatonin synthesis. High concentrations of tritiated dexamethasone were localized in the pineal gland indicating the presence of a glucocorticoid receptor (Warembourg, 1975). Corticosterone added to a rat pineal cell culture had no effect on basal melatonin levels, but blunted the melatonin rise normally seen during norepinephrine stimulation (Fevre-Montage and Abou-Samra, 1983).

Adrenocorticotropin (ACTH) has also been implicated in the regulation of pineal melatonin synthesis. ACTH has been found to increase protein synthesis in the rat pineal with a heightened response at midnight and blunted response at 1000 hours (Lynch et al., 1977). These authors believe that ACTH increases norepinephrine release from the sympathetic nerve endings by a calcium dependent process. The increased norepinephrine release promotes enhanced beta-adrenergic activity, enhanced cAMP formation and finally increased protein synthesis. If this is the case, ACTH would also presumably increase melatonin production by the same stimulatory pathway. Cardinali and co-workers (1976, 1981) found that ACTH had no effect on HIOMT activity, but reversed the depression of 5-HT seen in hypophysectomized rats.

Recent findings have also suggested that ACTH regulates HIOMT activity. Hypophysectomy decreased pineal HIOMT activity in rats and dexamethasone or ACTH injections restored HIOMT