A Comparison of the Mode of Termination of the Hippocampal and Hypothalamic Afferents to the Septal Nuclei as Revealed by Electron Microscopy of Degeneration

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Summary. Previous studies with the Nauta technique have established that fibres which originate in two important areas — the hippocampus and the hypothalamus — converge upon the cells of the septal nuclear complex. The purpose of this study was to investigate the anatomical basis of how the septal cells could differentiate between fibres from the two sources. Differences in the mode of termination of these two systems have been studied quantitatively at the electron microscope level by using the orthograde degeneration of terminals after lesions of the fimbria and the medial forebrain bundle. In the medial septal nucleus, the hippocampal fibres account for 35% of the terminals, and in the lateral septal nucleus, 43% of the terminals on the same side and a further 13% on the opposite side. These terminals are at least 98% axodendritic and 91% of them contain predominantly clear synaptic vesicles of 500 Å diameter. The hypothalamic fibres are the source of up to 19% of the axodendritic terminals in the medial septal nucleus, but considerably fewer in the lateral septal nucleus. In contrast to the hippocampal afferents, the hypothalamo-septal system has two characteristic features: firstly, the fibres give rise to up to 24% of the axosomatic terminals in the medial septal nucleus, and secondly, 63% of the terminals contain a population of vesicles with significantly higher proportions of dense centred vesicles of 800—1000 Å diameter.

Key Words: Septal nuclei — Afferent connexions — Ultrastructure — Synaptic degeneration

Introduction

Fibre degeneration techniques have shown that the nuclei of the septum receive two important groups of afferent fibres, one from the hippocampus and one from the hypothalamus. After lesions of either system, sections stained by the Nauta method display a dense network of degenerating fragments in the septum, but apart from differences in the relative density of this degeneration in the different parts of the septum, this light microscope material does not yield any information as to how these two groups of fibres may differ in their mode of termination. In the present study, the pattern of terminal degeneration in the septum after lesions of one or the other pathway was reinvestigated at the electron microscope level in an attempt to discover whether the two projections could be further differentiated by such features as their site of termination or the morphology of the terminals.
Some of the recent work on the fibre connexions and organization of the septum has already been reviewed (RAISMAN 1966) and here only the relevant features of the septal connexions will be considered (Fig. 1). The hippocampus gives origin to a major and complex fibre input to the septum. The fields of the regio inferior of the

Fig. 1. Diagrammatic representation of the two major afferent pathways to the septum and the position of the lesions and resulting degeneration. A = lesion of medial forebrain bundle; B = lesion of fimbria. The figures at the right represent the antero-posterior co-ordinates according to the atlas of De GROOT. Triangles: medial forebrain bundle degeneration; dots: fimbrial degeneration. AC = anterior commissure; CC = corpus callosum; CS = corpus striatum; D = diagonal band; DG = dentate gyrus; F = fimbria; Fx = fornix column; H = hippocampus; L = lateral septal nucleus; M = medial septal nucleus; MF = medial forebrain bundle; MH = medial hypothalamus; OC = optic chiasma; OP = optic tract; PO = preoptic area; SH = stria habenularis; ST = stria terminalis; V = ventral hippocampal commissure