Development of the Brainstem and Cerebellum in Autistic Patients

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Studies of magnetic resonance images have revealed morphological disorders of the brainstem and cerebellum in autistic children and adults. When we studied development of the brainstem and cerebellum in autistic patients, we found that although the brainstem and cerebellum significantly increased in size with age in both autistic patients and controls, these structures were significantly smaller in autistic patients than in controls. The speed of development of the pons, the cerebellar vermis I–V and the cerebellar vermis VI–VII was significantly more rapid in autistic patients than in the controls. However, the speed of development of the other brain structures in the posterior fossa did not differ between autistic patients and controls. The regression intercepts of the brainstem and cerebellum as well as those of their components were significantly smaller in autistic patients than in controls. Results suggest that brainstem and vermian abnormalities in autism were due to an early insult and hypoplasia rather than to a progressive degenerative process.

INTRODUCTION

There is a growing acceptance of infantile autism as an organically based neurodevelopmental disorder involving both cognitive and social deficits. Pathologic studies have demonstrated a loss of neurons (Purkinje and granular cells) from the cerebellar hemisphere and vermis (Arin, Bau-

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man, & Kemper, 1991; Bauman, 1991; Bauman & Kemper, 1985; Ritvo et al., 1986; Williams, Hauser, Purpura, DeLong, & Swisher, 1980). Although no neuropathologic changes have been found in the brainstem in autism (except for one case) (Bauman, 1991), physiologic studies such as auditory brainstem evoked potentials and short latency somatosensory evoked potentials have revealed some brainstem dysfunction (Hashimoto, Tayama, & Miyao, 1986; Ornitz, 1985, 1987, 1988; Thivierge, Bedard, Cote, & Maziade, 1990). The majority of recent neuroradiological studies have demonstrated cerebellar hypoplasia and/or a small brainstem, including the midbrain, pons, and medulla oblongata, in autistic patients (Ciesielski et al., 1990; Courchesne, Saitoh, et al., 1994a; Courchesne, Townsend, & Saitoh, 1994b; Courchesne, Yeung-Courchesne, Press, Hesselink, & Jernigan, 1988; Gaffney, Kuperman, Tsai, & Minchin, 1988; Gaffney, Tsai, Kuperman, & Minchin, 1987; Hashimoto, Murakawa, Miyazaki, Tayama, & Kuroda, 1992a; Hashimoto, Tayama, Miyazaki, Murakawa, & Kuroda, 1993a; Hashimoto et al., 1993b; Hashimoto, Tayama, et al., 1992b; Kleiman, Neff, & Rosman, 1992; Murakami, Courchesne, Yeung-Courchesne, & Hesselink, 1989; Piven et al., 1992). A minority of studies, however, have not found any abnormalities in the posterior fossa structures of the brain (Garber & Ritvo, 1992; Hsu, Yeung-Courchesne, Courchesne, & Press, 1991). Except for three studies (Courchesne et al., 1994a, 1994b, Hsu et al., 1991), the number of autistic subjects in MR studies of the posterior fossa has been small and the effect of brain development has not been studied. Differing results may therefore have been related to small study samples and a failure to understand the role of brain development.

The aim of this study was to investigate the neuroradiologic development of the brainstem and cerebellum in a large number of autistic patients from early infancy to adulthood and to compare the developmental patterns of autistic patients with those of mentally normal controls without autistic behavior.

**SUBJECTS AND METHOD**

Subjects were 102 autistic patients ranging in age from 6 months to 20 years ($M = 6.10 \pm 4.70$ years) and 112 controls from 3 months to 20 years ($M = 7.10 \pm 5.38$ years). Forty-five autistic and 59 control subjects were the same as those appearing in the author's previous reports (Hashimoto et al., 1992a, 1992b, 1993a, 1993b). The autistic patients and controls were divided into nine age groups (Group 1, 0-< 2 years; Group 2, 2-<