

Mega corpus callosum and caudate nuclei with bilateral hippocampal malformation

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ABSTRACT

A thick corpus callosum is an extremely rare condition with a limited number of reports in the literature. We report an unusual case of a thick corpus callosum and hypertrophic caudate nuclei with abnormal bilateral hippocampal development in a 15-year-old female who had mental and motor retardation.

Key words: • corpus callosum • dysgenesis
• hippocampus

The corpus callosum (CC) is the main interhemispheric commissure in the brain. Although many cases with hypoplasia and atrophy of the CC are seen in daily practice, a thick CC is an extremely rare condition with a limited number of reports in the literature (1–3). With the best visualization in midsagittal images, magnetic resonance imaging (MRI) is well suited for identifying abnormalities of the CC. Herein, we present a case of mega CC and caudate nuclei with abnormal bilateral hippocampal development.

Case report

The patient, a 15-year-old female, underwent cranial MRI for evaluation of mental and motor retardation. She was the second child born at term by normal vaginal delivery and without complication to healthy non-consanguineous parents. There was no history of perinatal hypoxia. Birth weight was 4500 g. There was no family history of neurological illness. At the age of 6 months she presented with poor head control and weak sucking reflex. No specific diagnosis was made at that time. Following an operation for strabismus at 6 years of age, she attended a special training center for 7 years.

When she presented at age 15 years, her examination revealed ataxic gait, self-mutilation, and spontaneous fits of laughter, but no facial dysmorphism. She was capable of forming sentences composed of only 2 words. Her parents did not describe any seizure activity.

Laboratory analysis of serum and urine, and electroencephalogram were unremarkable. Her intelligence quotient according to the Stanford-Binet scale was 47.

MRI of the brain was performed on a 3.0 Tesla MR system (Allegra, Siemens Medical Systems, Erlangen, Germany), which included sagittal and transverse T1-weighted (W) spin echo (SE) (TR/TE: 650/20 ms), and transverse and coronal T2-W turbo spin-echo (TSE) (TR/TE: 4000/114 ms) images. The examination was performed under light sedation.

On visual inspection, a thick CC was present (Fig. 1a). To be objective, morphometric analysis was performed in respect to length, thickness, and area of the CC, and area of the supratentorial supracallosal compartment (SSC) (Figs. 1b, 1c). Morphometric analysis of the CC was performed on the midsagittal T1-W image. Length of the CC was normal (88.6 mm; age-matched normal individual: 71.3 mm) (Figs. 1b, 1d). The values obtained were compared to normal values for her age in the literature (1). Thickness of the CC was diffusely increased; the genu, body, and splenium were 17.6 mm (normal: 11 mm), 10.8 mm (normal: 6 mm), and 11.3 mm (normal: 11 mm) thick, respectively (Fig. 1b). The genu was affected most strikingly. Areas of the CC and SSC were 1492 and 8145 mm², respectively (Fig. 1c). The area of the CC was apparently greater than that obtained from a recent study performed on adult

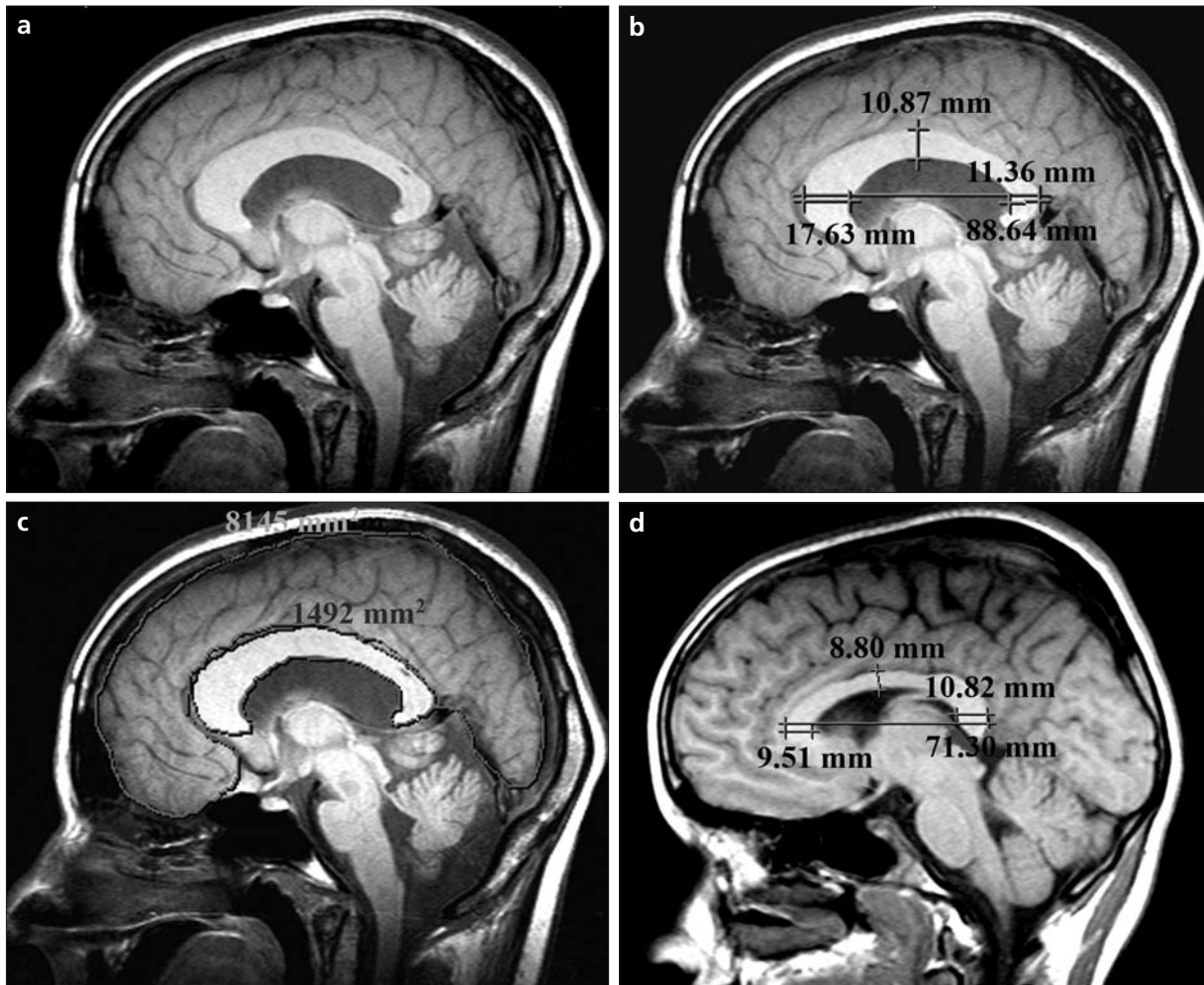


Figure 1. a-d. Midsagittal T1-weighted (TR/TE: 650/20 ms) MR image (a) of the patient shows a thick corpus callosum. Also note the enlarged perivascular space in the splenium. The genu is thicker than the splenium. Measurement of corpus callosum thickness and length (b), and area of the corpus callosum and supratentorial supracallosal compartment (c) are shown. For comparison, the MR image of a normal 15-year-old female is shown (d).

Turkish females (2) (Fig. 1d); however, the area of the SSC was normal (average callosal and supratentorial supracallosal areas were 608 and 8149 mm², respectively).

No sulcation abnormality or migration disorder was detected. Both caudate nuclei were enlarged and rounded. Additionally, the cavum septum pellucidum et vergae was observed on MRI examination (Fig. 2a).

On coronal T2-W images, bilateral hippocampal malformation was noted. They were small, short, round, and placed medially, with vertical collateral sulci (Fig. 2b).

Discussion

Formation of the CC occurs between the 8th and 20th gestational weeks when growth of the entire brain also takes place (3). Development of the

CC is greatly influenced by formation of the brain hemispheres; thus, CC abnormalities frequently coexist with various kinds of structural brain anomalies. Not infrequently, it is those associated anomalies that cause clinical symptoms in which isolated CC agenesis is detectable only with sophisticated psychoneurological tests. Brain injuries, cerebral atrophy, and myelination disorders may cause focal or diffuse thinning of the CC. With some exceptions, such as holoprosencephaly, or syntelencephaly, morphological analysis of the CC allows differentiation between callosal hypodysgenesis and destructive processes (4). Normal measurements of the CC in the pediatric population were defined by Lai et al. in 1994 (1). Normal morphology of the CC, with the splenium as the thickest part, was altered in the present case in

which the genu was thicker than the splenium, i.e. the genu was predominantly affected. Many descriptions of CC configuration anomalies have been published. Most of these reports were of developmental failure, such as agenesis, hypogenesis, or acquired atrophic changes. A case with thick genu and body portions, in addition to agenesis of the splenium, was associated with a largely open Sylvian fissure, perisylvian and frontal polymicrogyria, multiple heterotopias, and facial and genitourinary abnormalities (5). Bilateral symmetric megalencephaly, a thick CC, enlarged white matter, and incomplete opercularization were reported in 3 cases by Gohlich-Ratmann et al. (6). Morphometric analysis of the CC was made in 2 of these 3 cases and the genu was found to be thicker than the splenium in both. The authors sug-

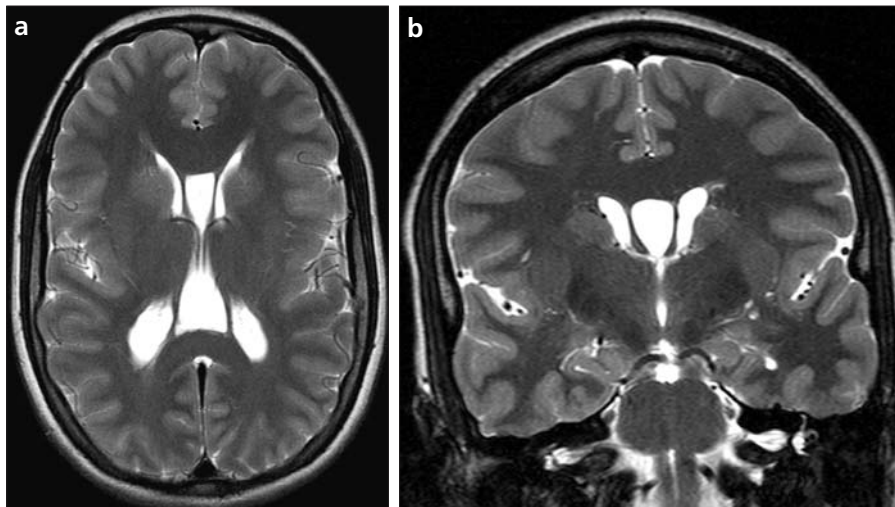


Figure 2. a, b. Transverse T2-weighted (TR/TE: 4000/114 ms) turbo spin-echo MR image (a) shows large, round caudate nuclei and the cavum septum pellucidum. Coronal T2-weighted turbo spin-echo (TR/TE: 4000/114 ms; section thickness: 3 mm) MR image (b) shows malrotation of both hippocampi.

gested that thickening of the CC might have occurred as a consequence of bi-hemispheric overgrowth (6). However, in the presented case, the area of the CC was significantly increased despite a normal SSC area. Hence, we cannot attribute callosal hypertrophy to cerebral overgrowth in our case. Moreover, 2 separate studies on type-1 neurofibromatosis patients showed increased callosal size in comparison to normal individuals, which could not be explained solely by the presence of macrocephaly (7, 8). Increase in size and/or number of axons in Rhesus monkeys due to thickened myelin or decreased apoptosis, which normally occur in the CC in the sixth postnatal month, were suggested etiologies (9). Our patient did not have any neurocutaneous stigmata. A study that examined MRI abnormalities in 18 patients with Cohen Syndrome (characterized by typical facial and structural features, mental retardation, microcephaly, ophthalmologic symptoms, granulocytopenia, and cheerful disposition) reported a relatively enlarged CC as the main finding (10). Clinical findings did not meet the diagnostic criteria of Cohen syndrome in our patient. A thick and short CC in 2 unrelated cases with hypertrichosis, hyperkeratosis, mental

retardation, and facial dysmorphism was reported by Poyhonen et al. (11). Prenatal diagnosis can be performed, as was done by Cavichioni et al. in a patient who suffered from facial dysmorphism and Wilms's tumor of the kidneys (12).

Given that the 3 steps in callosal development are commiseration, establishment of the callosal fiber tracts, and maturation, the unusually thick CC in the presented case might have resulted from an abnormality in the maturation step or perhaps in postnatal progressive myelination of the CC (13). Although it is known that many neuronal migration and hippocampal developmental abnormalities coexist with CC dysgenesis, the presence of bilateral hippocampal malrotation and caudate nuclei hypertrophy in conjunction with mega CC distinguishes the presented case.

In conclusion, with the increased use of MRI, a much higher incidence of CC anomalies have been diagnosed and it appears that further investigation of associated abnormalities and their relationship to a thick CC is needed. Thus, morphology of the CC should be carefully scrutinized, especially on midsagittal MRI in children with motor and/or mental retardation, facial dysmorphism, and seizure.

References

- Iai M, Tanabe Y, Goto M, Sugita K, Niimi H. A comparative magnetic resonance imaging study of the corpus callosum in neurologically normal children and children with spastic diplegia. *Acta Paediatr* 1994; 3:1086–1090.
- Erdogan N, Ulger H, Tuna I, Okur A. A novel index to estimate the corpus callosum morphometry in adults: callosal/supratentorial-supracallosal area ratio. *Diagn Interv Radiol* 2005; 11:179–181.
- Barkovich AJ. *Pediatric Neuroimaging*. 3rd ed. New York: Raven Press, 1995;254–261.
- Robertson R, Caruso PA, Truwit CL, Barkovich J. Disorders of brain development. In: Atlas SW ed. *Magnetic resonance imaging of the brain and spine*. 3rd ed. Philadelphia: Lippincott Williams&Wilkins, 2002; 279–370.
- Rypens F, Sonigo P, Aubry MC, et al. Prenatal MR diagnosis of a thick corpus callosum. *AJNR Am J Neuroradiol* 1996; 17:1918–1920.
- Gohlich-Ratmann G, Baethmann M, Lorenz P, et al. Megalencephaly, mega corpus callosum, and complete lack of motor development: a previously undescribed syndrome. *Am J Med Genet* 1998; 79:161–167.
- Mott SH, Baumgartner T, Vezina LG, et al. Neurofibromatosis type 1: corpus callosum enlarged beyond megalencephaly. *Ann Neurol* 1996; 40:325.
- Dubowski CE, Booth TN, Vezina G, et al. MR imaging of the corpus callosum in pediatric patients with neurofibromatosis type 1. *AJNR Am J Neuroradiol* 2001; 22:190–195.
- LeMantia AS, Rakic P. Axon overproduction and elimination in the corpus callosum of developing rhesus monkey. *J Neurosci* 1990; 10:2156–2175.
- Kivitie-Kallio S, Autti T, Salonen O, Norio R. MRI of the brain in the Cohen syndrome: a relatively large corpus callosum in patients with mental retardation and microcephaly. *Neuropediatrics* 1998; 29:298–301.
- Poyhonen MH, Peippo MM, Valanne LK, et al. Hypertrichosis, hyperkeratosis, abnormal corpus callosum, mental retardation and dysmorphic features in three unrelated females. *Clin Dysmorphol* 2004; 13:85–90.
- Cavichioni O, Gomes DM, Leroy B, et al. Prenatal diagnosis of de novo (7;19)(q11.2;q13.3) translocation associated with a thick corpus callosum and Wilms tumor of the kidneys. *Prenat Diagn* 2005; 25:876–878.
- Destrieux C, Velut S, Kakou M. Developpement du corpus calleux. *Neurochirurgie* 1998; 44:11–16.