Investigation of hydrocephalus with three-dimensional constructive interference in steady state MRI

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N. Kurihara · S. Takahashi · H. Tamura · S. Higano · S. Furuta · A. Umetsu
Department of Radiology, Tohoku University, Miyagi, Japan

N. Kurihara (✉)
Department of Radiology, National Sendai Hospital, 2-8-8, Miyagino, Miyagino-ku, Sendai, Miyagi 983-8520, Japan
e-mail: nkuri925@aol.com
Tel.: +81-22-293-1111
Fax: +81-22-293-1152

H. Tamura
Department of Radiology, Research Institute of Brain and Blood Vessels, Akita, Japan

H. Jokura
Department of Neurosurgery, Tohoku University, Miyagi, Japan

Abstract We report four patients with various types of hydrocephalus in whom constructive interference in steady state (CISS) MRI disclosed the cause of the hydrocephalus. The imaging clearly delineated an abnormal contour of the ventricular system and intraventricular septa, essential information for surgical planning, including endoscopic surgery. Postoperative CISS images were useful for showing not only regression of hydrocephalus but also the patency of small fenestrations.

Key words Hydrocephalus · Magnetic resonance imaging, pulse sequences · Neurosurgery, endoscopic

Introduction
Constructive interference in steady state (CISS) MRI, a steady-state free precession (SSFP) sequence, avoids the motion-induced signal reduction of the cerebrospinal fluid (CSF) by using symmetrical flow-compensating gradient pulses and provides high-resolution heavily T2-weighted images with good contrast between the CSF and other structures. It has been used for diagnosing cerebellopontine angle and labyrinth lesions in recent years [1–5].

We report the efficacy of CISS imaging in delineating the cause of atypical hydrocephalus.

Case reports
Case 1 (multiloculated hydrocephalus)
A boy was born at 39 weeks with 3000 g body weight and 35 cm head circumference. His neck was unstable even at 8 months of age, and he had macrocephaly. MRI at 1 year of age revealed hydrocephalus with septa. His head circumference became larger, and seizures started at 18 months of age. He was admitted at 3 years of age, when he could not stand alone and spoke few meaningful words. He had a mild right hemiparesis and his head circumference was 60.5 cm (over 2SD). T1-and T2-weighted images showed further dilatation of the ventricular system, predominantly on the left, and CISS images (TR/TE = 12.2/5.9 ms, matrix 256 × 512, slice thickness 1 mm, total acquisition time 5 min 53 s) delineated internal septa more clearly than the conventional
**Fig. 1a–d** A 3-year-old boy with multilocular hydrocephalus. Agenesis of corpus callosum was suggested previously. **a** T2-weighted image shows severe ventricular dilatation especially of the anterior horn and body of the left lateral ventricle. **b** Axial CISS image clearly demonstrates multiple complex septa. **c, d** Postoperative axial and reconstructed coronal CISS images demonstrate small fenestrations clearly (arrows), and reduction in size of the left lateral ventricle, associated with a subdural effusion imaging (Fig. 1a,b). He underwent an endoscopic fenestration of the left lateral and third ventricles. Postoperative CISS images showed not only reduction in the left lateral ventricular size but also the small fenestrations, not seen on conventional imaging (Fig. 1c,d). Postoperatively, the seizures disappeared.

**Case 2 (unilateral hydrocephalus)**

A 12-year-old girl with known neurofibromatosis 1 underwent enucleation of the right eye and osteoplasty of the right orbit at