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Short Communication

Transient central diabetes insipidus after cranioplasty for craniosynostosis in an infant with septo-optic dysplasia

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Highlights

- We report the fourth septo-optic dysplasia case with craniosynostosis.
- Transient central diabetes insipidus occurred after cranioplasty.
- Decrease in increased intracranial pressure may cause vasopressin deficiency.

Key words: central diabetes insipidus, cranioplasty, craniosynostosis, septo-optic dysplasia, transient

Introduction

Septo-optic dysplasia (SOD) is characterized by the absence of the septum pellucidum, hypoplasia of the optic nerve, and deficiency of the anterior and posterior pituitary hormones (1). Craniosynostosis is a rare complication of SOD, and its frequency in SOD is unknown. Among three reported SOD cases with craniosynostosis, one patient underwent transverse craniectomy and developed no apparent postoperative complications (2–4). Currently, the postoperative complications of cranioplasty for SOD are not elucidated. Here, we report a case of an infant with SOD who developed transient central diabetes insipidus (DI) after cranioplasty for craniosynostosis.

Case Report

The patient was the first child of healthy and non-consanguineous Japanese parents. He was delivered vaginally at 39 wk of gestation without asphyxia. His weight and length at birth were 3,103 g (+ 0.30 standard deviation [SD]) and 51.0 cm (+ 1.14 SD), respectively. At 23 d of life, an investigation for persistent jaundice (total bilirubin 15.6 mg/dL, direct bilirubin 2.6 mg/dL) revealed central hypothyroidism (thyroid stimulating hormone 8.00 μU/mL, free thyroxine 0.43 ng/dL), for which levothyroxine was started. However, the jaundice remained unresolved upon examination at 3 mo of age. The patient was referred to our hospital for further examination and treatment. Ophthalmologic examination showed the absence of smooth pursuit eye movements, presence of nystagmus, and bilateral optic

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nerve hypoplasia. A gonadotropin-releasing hormone loading test revealed low gonadotropin secretion (basal/peak levels of luteinizing and follicle-stimulating hormones of 0.4/1.6 and 0.6/1.3 mIU/mL, respectively). A corticotropin-releasing hormone loading test showed low cortisol secretion (basal/peak cortisol levels of 1.1/4.6 μg/dL), suggesting adrenocorticotropic hormone deficiency. Hydrocortisone therapy was initiated, which resulted in jaundice resolution. Head magnetic resonance imaging showed hypoplasia of the pituitary gland and an invisible pituitary stalk, and the T1-weighted image showed low-signal intensity in the posterior pituitary gland (**Fig. 1**). Based on optic nerve hypoplasia and pituitary hormone deficiency, we clinically diagnosed the patient with SOD.

When the patient was 9 mo old, his mother noted a prominence of the metopic suture and trigonocephaly. Head computed tomography (CT) showed premature fusion of the right coronal suture and partial fusion of the sagittal suture, although the metopic suture had a physiological fusion (**Fig. 2**). CT also showed thumb printings of the skull, suggesting increased intracranial pressure (ICP). Motor skill developmental delays, such as difficulty in sitting without support, were noted at 12 mo of age. He consumed weaning food thrice a day, along with 42 mL/kg/d of milk. Posterior cranial vault expansion was performed using distraction osteogenesis with a perioperative stress dose of glucocorticoids. In the prone position, a zigzag bi-coronal incision was made anterior to the posterior calvarial osteotomy, which was extended from the vertex to the transverse sinus. The calvarial segment was not elevated in the dura. The two internal distractors were positioned on each side parallel to the Frankfort plane. There was no hypotension or hypoxemia during the surgery. The patient received 400 mL of extracellular fluid, 250 mL of red blood cells, and 190 mL of fresh frozen plasma. Overall, 840 mL (16.5 mL/kg/h) of infusion and approximately 100 mEq of sodium were intravenously injected. The urine and bleeding volume were 370 mL (7.3 mL/kg/h) and 84 mL, respectively, accounting for a total of 454 mL (8.9 mL/kg/h). The preoperative serum sodium concentration was 139.5 mEq/L. Immediately post-operation, the whole blood sodium concentration, plasma osmolality, urine specific gravity, and urine osmolality were 154 mEq/L, 304 mOsm/L, 1.004, and 127 mOsm/L, respectively (**Fig. 3**). Suspecting central

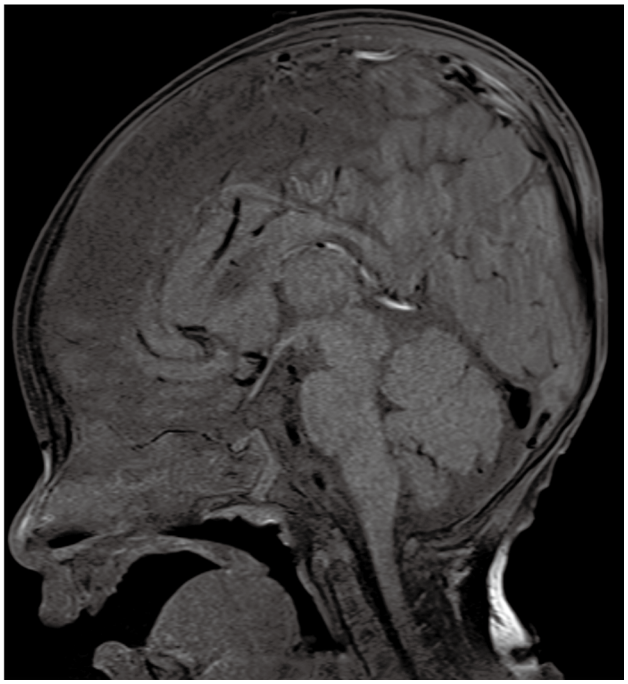

Fig. 1. T1-weighted sagittal magnetic resonance image of the brain showing hypoplasia of the pituitary gland, an invisible pituitary stalk, and low-signal intensity of the posterior pituitary gland.

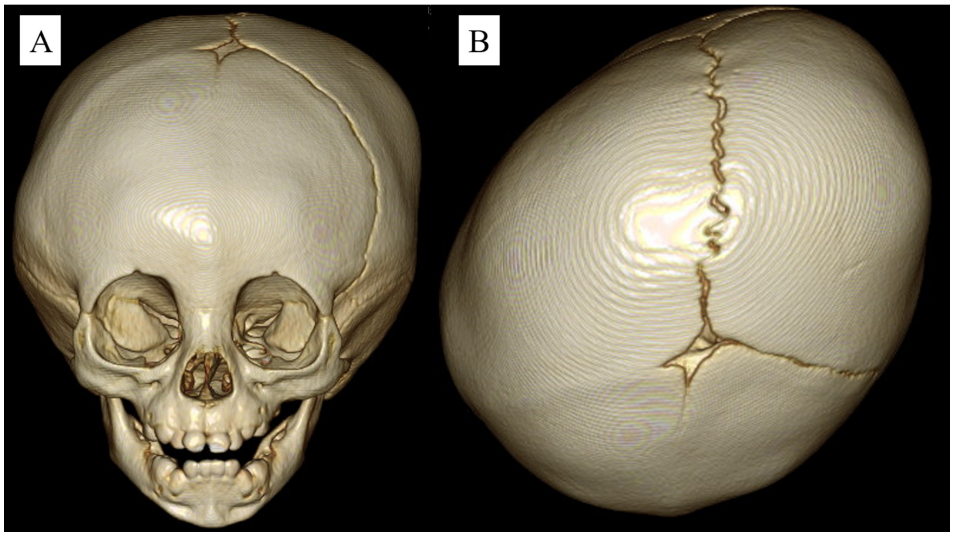

Fig. 2. Three-dimensional reconstruction of the computed tomography scans of the cranium.
(A) Frontal view: a premature fusion of the metopic and right coronal sutures is noted.
(B) Top view: a partial fusion of the sagittal suture is noted.

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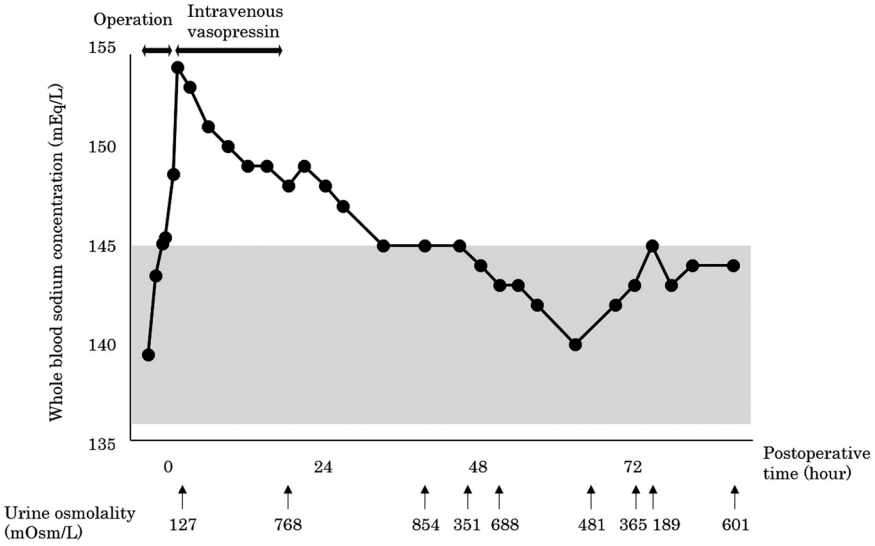

Fig. 3. Perioperative whole blood sodium concentration and urine osmolality. Immediately after cranioplasty, the whole blood sodium concentration is shown to increase to 154 mEq/L, and urine osmolality decreases to 127 mOsm/L. Intravenous vasopressin is shown to improve hypernatremia, and, on discontinuation, the whole blood sodium concentration remains within normal limits. The gray shaded area represents the local reference for whole blood sodium concentration (136–145 mEq/L).

DI, we intravenously injected a bolus of 0.36 mIU/kg of vasopressin and started its continuous infusion at 0.36 mIU/kg/h. An hour later, urine volume decreased, and urine specific gravity increased to 1.010. We increased the vasopressin dose to 0.73 mIU/kg/h. After 15 h of continuous vasopressin infusion, the whole blood sodium concentration decreased to 149 mEq/L, and the infusion was discontinued (**Fig. 2**). Total water intake including intravenous infusion and nasogastric tube feeding on the 1st and 2nd postoperative days were 75 and 49 mL/kg, respectively, and urine volume was 1–2 mL/kg/h. On the 2nd postoperative day, the milk intake returned to the preoperative level. On the 3rd postoperative day, the intake of weaning food thrice a day was resumed. The total water intake on the 3rd and 4th postoperative days was 63 and 59 mL/kg, respectively. The urine volume was 2–10 mL/kg/h, possibly due to the postoperative diuretic period. After the 2nd postoperative day, serum sodium concentration remained within the normal range, and the urine osmolality was higher than the plasma osmolality, implying that the urine concentrating capability had returned to normal (**Fig. 3**). Laboratory examinations immediately after the operation revealed a plasma vasopressin concentration of 0.6 pg/mL with a serum sodium concentration of 153.5 mEq/L. Collectively, he was diagnosed with transient central DI. From the 4th to the 21st postoperative day, we extended each distractor by 1.0−1.5 mm/d, and the total amount of distraction length was 25.5 and 18.0 mm for both right and both left distractors. He was discharged on the 23rd postoperative day. At 1 yr and 7 mo of age, the distractors at the surface of the skull bones were surgically removed, and DI did not recur.

Ethical Statement

This study complies with all the relevant national regulations and institutional policies and is in accordance with the tenets of the Helsinki Declaration. It was approved by the Institutional Review Board (IRB) at Keio University School of Medicine (IRB number 20150104). Written consent was obtained from the patient's parents.

Discussion

In this article, we report a case of an infant with SOD who developed transient central diabetes insipidus after cranioplasty for craniosynostosis. To the best of our knowledge, this is the first report of transient central DI after cranioplasty in a patient with SOD.

We speculate that the reasons as follows may have contributed to the development of central DI in our patient: i) his vasopressin secretory reserve was probably inherently low due to SOD, and ii) the fluctuation in blood flow to the hypothalamus and pituitary gland with an associated decrease in ICP may have resulted in the dysregulation of vasopressin synthesis and secretion. The following observations support our hypotheses regarding the association between the pathogenesis of DI and decreased ICP. First, the surgical removal of the distractors placed at the surface of the skull bones in our patient did not trigger central DI. General anesthesia is unlikely to be a precipitating factor for transient central DI. Second, previous reports have shown that postoperative DI occurs in patients receiving endoscopic third ventriculostomy or ventriculoperitoneal shunting for hydrocephalus (5, 6). Notably, most cases of DI after endoscopic third ventriculostomy were reported to be transient (5). In our case, central DI was transient,

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probably due to the temporary fluctuation in blood flow, which is a causative factor associated with reduced ICP.

In our patient, vasopressin release did not respond appropriately to hypernatremia during or immediately after the surgery, despite the absence of dehydration. Although this condition was transient, the patient may develop permanent central DI in later life, considering that 43% of SOD patients developed central DI in a previous study (7). Thus, further follow-up of osmotic regulation is necessary for this patient.

In conclusion, clinicians should be aware of the possibility of central DI development during and after cranioplasty for SOD, and the serum sodium concentration, urine volume, and urine osmolality should thus be monitored.

Conflict of Interests: All authors declare no relevant financial relationships.

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