Neurocutaneous melanosis (NCM) is a rare congenital syndrome consisting of benign or malignant melanotic tumors of the central nervous system with large or numerous cutaneous melanocytic nevi. The Dandy-Walker complex (DWC) is characterized by an enlarged posterior fossa with high insertion of the tentorium, hypoplasia or aplasia of the cerebellar vermis, and cystic dilatation of the fourth ventricle. These each two conditions are rare, but NCM associated with DWC is even more rare. Most patients of NCM with DWC present neurological symptoms early in life such as intracranial hemorrhage, hydrocephalus, and malignant transformation of the melanocytes. We report a 14-year-old male patient who was finally diagnosed as NCM in association with DWC with extensive intracerebral and spinal cord involvement.

Key Words: Melanoma · Neurocutaneous syndrome · Dandy-Walker syndrome.
logical symptoms. The patient visited due to motor weakness. The computed tomography (CT) imaging scans showed intracerebral and intraventricular hemorrhage throughout left posterior frontal cortical area and left lateral ventricle. Under magnetic resonance image (MRI) gadolinium-enhanced T1 weighted image, partially high signal was detected in the cortical area of frontal lobe. Small inhomogenous high signal was also observed on the pons, temporal horn, and anterior portion of lateral ventricle through gadolinium-enhanced T1 weighted image. MRI scans also revealed a cyst in the posterior fossa and hypoplasia of the cerebellar vermis with dilatation of the entire ventricular system. Longitudinal diffuse enhancement lesion was observed along the posterior dura at the thoracic level in the whole spine MRI scans carried out for the purpose of screening but nodular lesion or focal mass lesion was not observed in other areas (Fig. 3). Although surgical treatment under NCM impression accompanies by DWC was recommended, we could not operate on him due to refusal by the guardian. After the conservative care during one month, the patient was discharged with improvement of neurological symptoms. However, the patient was hospitalized again with headache and right hemiparesis grade I after 4 months. Large mass, which is a marked enlarged state of left frontoparietal area, was observed under the MRI scans. The surgical treatment was performed. Tumor along with diffuse dark colored leptomeninges and with soft, friable, vascularized and poorly defined borders of margin was removed gross totally (Fig. 4). Histopathologic examination showed melanin-pigment laden neoplastic cells, necrotic change and pleomorphic malignant cell, which could be diagnosed the malignant melanoma (Fig. 5A-C). No pathologic de-
posits of the skin area were seen in the positron emission tomography with 18-FDG (Fig. 5D). It was possible to definitively diagnose NCM with DWC. After 2 month following first brain surgery, the patient was discharged with symptom improvement. Three months after discharge, the patient was hospitalized again with observation of increased intracranial pressure symptoms such as decreased mentality, headache and nausea. Re-grown large mass on the left frontoparietal area and new mass on left medial temporal area were observed under MRI scans (Fig. 6). The mass on the left frontoparietal area was removed gross totally once again through surgery with same pathological findings. On the 3rd week following the second surgical treatment, the patient complained of back pain, voiding difficulty, left side motor weakness grade III and respiratory difficulty. So spinal MRI scans was done, and mass lesion with high signal at the T2 weighted image and inhomogenous high signal at gadolinium-enhanced T1 weighted image along the C5–T3 area were observed, and bilateral laminectomy with partial removal of the mass was performed. The intradural mass showed a soft, friable, highly vascularized characteristics and infiltrated into the leptomeninges with extremely poorly defined border (Fig. 7). Although performing aggressive treatment, decreased of consciousness, respiratory difficulty and motor weakness continued in the patient, and progressive hydrocephalus was observed on CT scan. The guardian did not wish further treatment. The patient died on the 3rd week following the spine surgery.

**DISCUSSION**

Since the first report was described in 1861, the diagnostic criteria was established by Kadonaga and Frieden in 1991 (Table 1). To exclude the cases of cutaneous melanoma with brain metastasis, they suggested the no evidence of cutaneous melanoma except in patients in whom the examined portions of the meningeal lesions are benign. And the cases of definite NCM require histologic confirmation of the CNS lesions. On the other hand, the cases without histologic confirmation of CNS lesions are considered provisional.

NCM is a nonhereditary entity, which occurs equally in both sexes. The pathogenesis of NCM is not clear. Melanocytes normally exist in human epidermis, hair bulb, leptomeninges, uveal tract and retina, and are thought to be derived from multipotential precursor cells of the neural crest. And these neural crest cells normally migrate to their final position in embryonic skin by day 50 of development, and have been detected in fetal epidermis at 8–10 weeks and 5.5 months.
cells are important in cerebellar development. Many authors proposed that excessive melanosis of the leptomeninges may interfere with ectodermal-mesodermal interaction and normal cerebellar development. This developmental interference may lead to the clinical images of the DWC.

When neurologic symptoms occur, NCM generally has a poor prognosis regardless of the presence of malignancy. Furthermore, the concurrent existence of DWC appears to have a more poorer prognosis. Several authors reported that malignant transformation is seen in about 40–64% of cases with death presenting CNS complications. In presence of leptomeningeal malignant melanoma, the patients showed the rapid deterioration and tumor extension to CNS area through the leptomeninges.

The prognosis of provisional NCM (pNCM) with DWC was generally good. Most of their main symptoms were hydrocephalus and seizure. Nine of 11 patients of pNCM with DWC were alive when they were reported. On the other hand, the prognosis of definite NCM (dNCM) with DWC was very poor. The clinical symptoms of dNCM were more severe and the spinal involvement was more frequent. The eleven of 16 patients died of neurologic deterioration. The eight of 11 expired patients presented the malignant melanoma. Among the eight cases, six patients, including our case, showed the malignant transformation to CNS melanoma during the follow-up after diagnosis pNCM. Although the pNCM with DWC has a favorable prognosis, the possibility of the malignant transformation to CNS melanoma has been reported, as mentioned above. And so we suggest that the long-term follow-up will be needed for these pNCM with DWC.

CONCLUSION

After the diagnosis of NCM with DWC, there is no particular treatment to prevent the malignant change, so the physician needs the closed follow-up for the patients, even if the symptom are stable. In our study, this patient has prolonged survival period of about 14 years since the occurrence of seizure at the age of 2. After the stable period of 12 years, the patient showed the rapid progression of symptom and extension of tumor to brain and spinal cord. We reported a proper case, which presented the clinical progress from the malignant change of NCM to patient’s terminal state.

References

1. Akinwunmi J, Sgouros S, Moss C, Grundy R, Green S: Neurocutaneous melanosis with leptomeningeal melanoma. Pediatr Neurosurg 35: 277-279, 2001
2. Arai M, Nosaka K, Kashihara K, Kaizaki Y: Neurocutaneous melanosis associated with Dandy-Walker malformation and a meningoencephalocele. Case report. J Neurosurg 100 (5 Suppl Pediatrics): 501-505, 2004
3. Barkovich AJ, Frieden IJ, Williams ML: MR of neurocutaneous melanosis. AJNR Am J Neuroradiol 15: 859-867, 1994
4. Berker M, Oruckaptan HH, Oge HK, Beni K: Neurocutaneous melanosis associated with Dandy-Walker malformation. Case report and review of the literature. Pediatr Neurosurg 33: 270-273, 2000
5. Burstein F, Seier H, Hudgins PA, Zapiach L: Neurocutaneous melanosis. J Craniofac Surg 16: 874-876, 2005
6. Cacere A, Trejos H: Neurocutaneous melanosis with associated Dandy-Walker complex. Childs Nerv Syst 22: 67-72, 2006
7. Chaloupka JC, Wolf RJ, Varma PK: Neurocutaneous melanosis with the Dandy-Walker malformation: a possible rare pathoetiologic association. Neuroradiology 38: 486-489, 1996
8. Cho IY, Hwang SK, Kim SH: Dandy-walker malformation associated with neurocutaneous melanosis. J Korean Neurosurg Soc 50: 475-477, 2011
9. Craver RD, Golladay SE, Warrier RP, Gates AJ, Nelson JS: Neurocutaneous melanosis with Dandy-Walker malformation complicated by primary spinal leptomeningeal melanoma. J Child Neurol 11: 410-414, 1996
10. Demicri A, Kawamura Y, Sze G, Duncan C: MR of parenchymal neurocutaneous melanosis. AJNR Am J Neuroradiol 16: 603-606, 1995
11. Di Rocco F, Sabatino G, Koutzoglou M, Battaglia D, Caldarelli M, Tamburrini G: Neurocutaneous melanosis. Childs Nerv Syst 20: 23-28, 2004
12. Ellis DS, Spencer WH, Stephenson CM: Congenital neurocutaneous melanosis with metastatic orbital malignant melanoma. Ophthalmology 93: 1639-1642, 1986
13. Gönül M, Soyuş S, Gül U, Aslan E, Unal T, Engül G: Giant congenital melanocytic naevus associated with Dandy-Walker malformation, lipomatosis and hemihyper trophy of the leg. Clin Exp Dermatol 34: e106-e109, 2009
14. Green LJ, Nanda VS, Rotth GM, Barr RI: Neurocutaneous melanosis and Dandy-Walker syndrome in an infant. Int J Dermatol 36: 356-359, 1997
15. Hsueh CW, Hsiao CS, Chiu NC, Shen EY: Neurocutaneous melanosis with hydrocephalus: report of one case. Acta Neurol Taiwan 13: 29-33, 2004
16. Humes RA, Roskamp J, Eisenbrey AB: Melanosis and hydrocephalus. Report of four cases. J Neurosurg 61: 365-368, 1984
17. Kadonaga JN, Barkovich AJ, Edwards MS, Frieden IJ: Neurocutaneous melanosis in association with the Dandy-Walker complex. Pediatr Dermatol 9: 37-43, 1992
18. Kadonaga JN, Frieden IJ: Neurocutaneous melanosis: definition and review of the literature. J Am Acad Dermatol 24 (5 Pt 1): 747-755, 1991
19. Kalayci M, Çağavi F, Bayar U, Gül S, Dursun A, Ermiş B, et al.: Neurocutaneous melanosis associated with Dandy-Walker malformation. Acta Neurochir (Wien) 148: 1103-1106; discussion 1106, 2006
20. Kang SG, You DS, Cho KS, Kim DS, Chang ED, Huh PW, et al.: Coexisting intracranial meningeal melanocytoma, dermoid tumor, and Dandy-Walker cyst in a patient with neurocutaneous melanosis. Case report. J Neurosurg 104: 444-447, 2006
21. Kang KH, Chung SB, Kong DS, Seol HJ, Shin HJ: Neurocutaneous melanosis associated with Dandy-Walker complex and an intracranial cavernous angioma. Childs Nerv Syst 28: 309-314, 2012
22. Livingstone E, Claviez A, Spengler D, Barth H, Stark AM, Hugo HH, et al.: Neurocutaneous melanosis: a fatal disease in early childhood. J Clin Oncol 27: 2290-2291, 2009
23. Marnet D, Vinchon M, Mostofi K, Catteau B, Kerdraon O, Dhellemmes P: Neurocutaneous melanosis and the Dandy-Walker complex: an uncommon but not so insignificant association. Childs Nerv Syst 25: 1533-1539, 2009
24. McClelland S 3rd, Charnas LR, SantaCruz KS, Garner HP, Lam CH: Progressive brainstem compression in an infant with neurocutaneous melanosis and Dandy-Walker complex following ventriculoperitoneal shunt placement for hydrocephalus. Case report. J Neurosurg 107 (6 Suppl): 500-503, 2007
25. Mena-Cedillos CA, Valencia-Herrera AM, Arroyo-Pineda AI, Salgado-Jiménez MA, Espinoza-Montero R, Martínez-Avalos AB, et al.: Neurocutaneous melanosis in association with the Dandy-Walker complex, complicated by melanoma: report of a case and literature review. Pediatr Dermatol 19: 237-242, 2002
26. Pavlidou E, Hagel C, Papavasiliou A, Giouroukos S, Panteliasid C: Neurocutaneous melanosis: report of three cases and up-to-date review. J Child Neurol 23: 1382-1391, 2008
27. Reyes-Muñiga M, Chou P, Byrd S, Ray V, Castelli M, Gattuso P, et al.: Nevomelanocytic proliferations in the central nervous system of children. Cancer 72: 2277-2285, 1993
28. Schremil S, Gruendobler B, Schremil J, Bayer M, Ladoyanni E, Prantl L, et al.: Neurocutaneous melanosis in association with Dandy-Walker malformation: case report and literature review. Clin Exp Dermatol 33: 611-614, 2008
29. Walbert T, Sloan AE, Cohen ML, Koubiessi MZ: Symptomatic neurocutaneous melanosis and Dandy-Walker malformation in an adult. J Clin Oncol 27: 2886-2887, 2009
30. Yu HS, Tsaur KC, Chien CH, Perring JJ, Lu CC: Neurocutaneous melanosis: electron microscopic comparison of the pigmented melanocytic nevi of skin and meningeal melanosis. J Dermatol 12: 267-276, 1985