findings. The motor power of her lower limbs was normal, and rectal examination revealed normal anal tone. Magnetic resonance (MR) imaging showed a well-demarcated 1.5×1.9×2.9 cm sized mass lesion at L2-3. The mass was hypointense on T1- and T2-weighted images with homogeneous gadolinium enhancement. There was also a cystic lesion within the spinal cord on the cranial side of the mass at T12-L2. The cyst was isointense to the cerebrospinal fluid and was diagnosed to be tumor associated syrinx (Fig. 1). Myelography of the lumbar spine revealed obstruction of contrast flow due to the intradural mass. Operation was conducted with the presumptive diagnosis of intradural extramedullary meningioma. An L1-3 laminectomy and intradural exposure revealed a yellowish pink, well-encapsulated, elliptical mass of firm consistency. The tumor was found to be draped by and adhered to the nerve roots at its upper pole near the conus medullaris and cauda equina at its lower pole without dural attachment. However, the tumor was successfully dissected from the nerve roots and removed completely. The patient recovered uneventfully after the operation. The postoperative MR imaging showed no residual tumor with marked reduction of the syrinx. All of the patient’s preoperative symptoms improved after surgery. The histology of the tumor showed patternless sheets of polygonal cells with clear glycogen-rich cytoplasm and small clusters of cells in a meningothelial pattern with whorl formation (Fig. 2). A Periodic acid-Schiff (PAS) stain showed a positive reaction in the cytoplasm of tumor cells containing glycogen (Fig. 3). Tumor cells were stained positive for vimentin (Fig. 4) and epithelial membrane antigen (EMA). These findings were consistent with the diagnosis of clear cell meningioma. Postoperatively, the patient’s symptoms were dramatically alleviated. Ad-
Juvant therapy was not performed. The postoperative one-year follow-up MR imaging showed no evidence of tumor recurrence (Fig. 5). The patient has not had any complaints or neurological symptoms for two years.

**DISCUSSION**

Zorludemir et al.\(^{25}\) described clear cell meningioma as a distinct variant of meningioma for the first time in 1995. Scheithauer\(^{23}\) described its histologic and ultrastructural features. Although it is a benign variant of meningioma\(^{22}\), it is found to recur relatively frequently and even metastasize\(^{1}\); this behavior resulted in a change in its WHO classification from grade I to grade II\(^{10}\).

The proportion of spinal to total meningiomas is higher for clear cell meningiomas (45%) than for other meningiomas (the highest being 20% of the reported cases)\(^{19}\). They also tend to present at younger ages\(^{1,13}\) and occur in the lower thoracic, lumbar or lumbosacral region. Heth et al.\(^{6}\) believed that a family history might be a risk factor for this type of meningioma.

Histologically, clear cell meningioma contains sheets of clear, glycogen-rich (Periodic acid-Schiff positive, diastase-labile), polygonal cells forming only a few vague whorls\(^{25}\). Its abundant glycogen is what gives the name, “clear cell,” to this particular type of meningioma\(^{25}\). Whorl formation is histologic feature in the differentiation of clear cell meningioma from a metastatic deposit of so-called clear cell carcinoma, including renal cell carcinoma, which is negative or very weakly positive for vimentin. Microcystic meningioma should also be distinguished from clear cell meningioma, among other variants of meningioma\(^{25}\).

Although both tumors have a clear appearance, microcystic meningioma has clear extracellular spaces of varying size that contain pale fluid, whereas the clear cytoplasm of clear cell meningioma is relatively uniform and contains abundant glycogen\(^{25}\).

The imaging features of clear cell meningiomas do not differ from those of other common types of meningiomas\(^{8}\). Spinal clear cell meningioma usually occurs as an intradural extramedullary tumor with fairly homogeneous contrast enhancement\(^{11}\). Some cases show foraminal extension lacking dural attachment, just like schwannomas\(^{21}\). Even an intramedullary clear cell meningioma has been reported\(^{19}\). Because of radiologic and gross morphologic similarities between the spinal meningiomas and other intradural extramedullary spinal tumors including schwannomas, neurofibromas, paragangliomas and myxopapillary ependymomas, accurate histological diag-

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**Fig. 1.** Sagittal magnetic resonance imaging shows a well-demarcated mass lesion at L2-3. The mass lesion is hypo-intense on T1-weighted (A) and T2-weighted (B) images and shows homogeneous enhancement with gadolinium (C). There is a cystic lesion within the spinal cord on the cranial side of the mass at T12-L2. The cyst is iso-intense with cerebrospinal fluid (A, B and C).

**Fig. 2.** Photomicrograph showing patternless sheets of polygonal cells with clear glycogen-rich cytoplasm and small clusters of cells in a meningothelial pattern with whorl formation (A, H&E ×200) (B, H & E ×400).

**Fig. 3.** Photomicrograph of Periodic acid-Schiff stain showing positive reactions in the cytoplasm of tumor cells containing glycogen (×400).

**Fig. 4.** Tumor cells staining positive for vimentin (×400).
nosis is imprortant. It is noteworthy that some clear cell meningiomas are not attached to the dura but to the neural sheath, as in the present case. Twelve such non dura-based intraspinal clear cell meningioma have been reported to date (Table 1).

Because of the rarity of this type of meningioma, it was difficult for us to draw conclusive methods of treatment, especially in regard to radiotherapy. Another problem with treatment planning is that there has been discrepancies between histological findings and prognosis, showing no histologic features having prognostic significance. Total surgical removal is the goal of treatment. Subtotal resection is likely to have recurrence or progression. Statistically, the role of radiotherapy has not been proven to be effective, but there has been a tendency towards a lower recurrence rate after postoperative radiotherapy. On the other hand, some authors have suggested that radiotherapy should be performed only after partial resection or at recurrence. In young children with clear cell meningioma, in particular, Carra et al. have suggested a reasonably aggressive surgical approach at diagnosis whenever possible, followed by meticulous follow-up in consideration of the potential serious late effects of radiotherapy.

The recurrence rate of clear cell meningioma is reported to be 42-61% in operative cases. Intraspinal clear cell meningio- 

ma is associated with a lower rate of recurrence than the intracranial variant. Of the patients described in the literature who had no recurrences, all had undergone gross-total resection. The follow-up plan should include imaging of the entire neuroaxis for possible metastasis.

CONCLUSION

Intraspinal clear cell meningioma is an uncommon WHO grade II meningioma with high recurrence rate in cases of partial removal. We report a rare case of cauda equina clear cell meningioma without dural attachment, which was successfully treated by gross total resection.

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Table 1. Summary of cases with non-dura based intraspinal clear cell meningiomas in the literature

| No. | Authors | Age/Sex | Location | Follow-up | Root involvement, Encapsulation |
|-----|---------|---------|----------|-----------|--------------------------------|
| 1   | Holtzmann | 32/M    | L3-4     | NED at 1 months | Root (+), Capsule (+) |
| 2   | Dubois   | 10/F    | L1-4(Cauda Equina) | NED at 6 months, | Root (+), Capsule (+) |
| 3   | Maxwell  | 31/F    | L3       | NED at 12 months | Root (+), Capsule (NA) |
| 4   | Matsui   | 9/F     | T12, Cauda equina, L5 | Recurrence at 6 months | Root (+), Capsule (NA) |
| 5   | Jallo    | 8/F     | Cauda equina | Recurrence at 10 weeks with CPA metastasis | Root (NA), Capsule (+) |
| 6   | Current case | 22 Mo/F | C3-5     | NED at 42 months | Root (NA), Capsule (NA) |
| 7   | Carra    | 1/M     | T12-S1   | NED at 61 months | Root (+), Capsule (+) |
| 8   | Payano   | 24/M    | L3-4     | NED at 52 months | Root (+), Capsule (+) |
| 9   | Chen     | 19/F    | L3       | NED at 6 months | Root (+), Capsule (+) |
| 10  | Park     | 41/F    | L4-5     | NED at 2 years | Intradural, Capsule (NA) |
| 11  | Oviedo   | 65/F    | T9-10    | NED at 1 year | Root (NA), Capsule (NA) |
| 12  | Oviedo   | 7/M     | L3       | NED at 2 years | Root (+), capsule (+) |
| 13  | Current case | 34/F | Cauda equina | NED at 2 years | Root (+), capsule (+) |

CPA : cerebellopontine angle, NA : not available, NED : no evidence of disease, Root (+) : adhesion to nerve root confirmed in the literature, Capsule (+) : existence of capsule confirmed in the literature
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