INTRODUCTION

Spinal schwannomas are benign tumors arising from the sheath of the spinal nerve roots and occasionally occur in the cauda equina. Tumors in the cauda equina often attain considerable size without painful symptoms, because of the mobility of the roots and the wide intradural space. Giant schwannomas of the cauda equina that involve many nerve roots are rare. Those that occur, however, are usually observed in an intrasacral region, and are rarely ossified. We describe here an unusual case of giant schwannoma of the cauda equina with dystrophic calcification, which was completely removed without any neurological deterioration.

CASE REPORT

A 21-year-old man presented with a 12-month history of urinary dysfunction and numbness below the buttocks. Plain radiography showed scalloping of the posterior surface of the vertebral bodies from L4 to the sacrum, and magnetic resonance imaging and computed tomography revealed a giant cauda equina tumor with dystrophic calcification. The tumor was completely removed, with intraoperative neurophysiologic monitoring. Histopathologic examination showed that the tumor was a schwannoma. The patient's postoperative course was uneventful, with urinary function and numbness gradually improving. Although a giant schwannoma accompanied by dystrophic calcification is extremely rare, such a tumor can be removed safely and completely by meticulous dissection and careful neuromonitoring of the cauda equina spinal nerves involved in the tumor.

Key Words: Giant schwannoma · Cauda equina · Complete excision · Calcification · Neuromonitoring.
laminae were fixed by insertion of mini-plates and screws. Because the patient had good bone quality and a stable vertebral column, further spinopelvic reconstruction was not performed. Histologic examination of the resected tumor revealed that it was a schwannoma. Total operating time was 6 hours and blood loss was estimated to be 750 mL. The postoperative course was uneventful and the patient experienced significant relief of urinary dysfunction. Sensation and sphincter function gradually improved. After one week of bed rest, the patient was permitted to walk using a hard brace and walker. At the most recent follow-up, his urinary and anal sphincter dysfunction almost disappeared, and the hypesthesia in both buttocks was mild. He walks smoothly without a cane or any aid. MR and plain imaging 3 years after surgery showed no evidence of any residual tumor, vertebral fracture, or instability (Fig. 4).

**DISCUSSION**

Giant schwannomas of the cauda equina of the spinal canal, with pedicle erosion and/or widening of the neural foramen, have been described\(^6\,^{10,14,15}\). However, because of dystrophic calcification, an accurate preoperative diagnosis was difficult in the present patient. Scallopion of the posterior surface of the vertebral bodies strongly suggested a disease of long-standing etiology. Although we suspected that the symptoms were attributable to a slow-growing tumor, such as a schwannoma, such tumors are rarely calcified or ossified. Thus, these situations led us to perform CT-guided needle biopsy. Our preoperative differential diagnoses included ganglioneuroma and schwannoma of the ancient type, both of them are benign mesenchymal tumors.

By searching the English language literature using the terms ‘schwannoma,’ ‘cauda equina,’ ‘giant,’ and ‘tumor’ since 1960, we identified reports describing 29 patients with giant cauda equina schwannomas. After excluding five patients, four with malignant peripheral nerve sheath tumors and one without enough clinical information, 24 patients remained, including the patient described here. Table 1 summarizes data on patients with giant schwannoma of the cauda equina\(^4,6,10,14,17,19\), including seven with intrasacral schwannoma\(^8,11,13,15,16,18\) and one with intrasosseous schwannoma\(^3\) arising from nerves within bones. Only one patient with a giant cauda equina schwannoma associated with a small ossification has been reported to date\(^6\). Thus, to the best of our knowledge, a giant schwannoma in the

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**Fig. 1.** Preoperative sagittal magnetic resonance images of our patient. A : T2-weighted image. B : T1-weighted image. C : Gadolinium-enhanced T1-weighted image. Note the giant cauda equina tumor growing into the vertebral bodies and neural foramina from L3 to S2.  
**Fig. 2.** CT scans showing a large calcified mass in the enlarged spinal canal and neural foramen.  
**Fig. 3.** Intraoperative photograph showing a large calcification (arrow) in the tumor.
Giant Calcified Schwannoma of the Cauda Equina  

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Giant calcified schwannoma of the cauda equina accompanied by dystrophic calcification has not been previously reported.

Complete excision, taking care not to damage nerves, is the recommended treatment for such locally aggressive benign tumors, as partial resection carries a risk of local recurrence and re-operation is much more difficult and dangerous than the complete excision.

Table 1. Reported cases of giant cauda equina schwannomas from the currently available English literature since 1960

| No. | Authors            | Year | Age/Sex | Location | Resection | Spinal reconstruction | Neurological deterioration | Follow-up (+ : recurrence) |
|-----|--------------------|------|---------|----------|-----------|-----------------------|---------------------------|-----------------------------|
| 1   | Dickson et al.     | 1971 | 51/F    | L2–L4    | Complete  | +                     | -                         | 2 years, NER                |
| 2   | Natarajan et al.   | 1975 | 23/F    | L2–L4    | Complete  | +                     | -                         | 1 month, NER                |
| 3   | Wu                 | 1980 | 48/M    | T11–L4   | Incomplete | -                     | -                         | 22 years, NER               |
| 4   | Wu                 | 1980 | 29/M    | L2–L5    | Incomplete | -                     | +                         | 4 years, NER, RTx           |
| 5   | Rengachary et al.  | 1981 | 28/M    | S1–S4    | Complete  | -                     | +                         | 3 months, NER, Intrasacral  |
| 6   | Lesoin et al.      | 1984 | 15/M    | L5–S5    | Complete  | -                     | +                         | 6 months, NER, Intrasacral  |
| 7   | Kogame et al.      | 1985 | 52/F    | L2–L5    | Incomplete | +                     | -                         | NA, NER                     |
| 8   | Kogame et al.      | 1985 | 34/F    | T10–L5   | Incomplete | -                     | -                         | NA, +                       |
| 9   | Fujikawa et al.    | 1985 | 34/M    | T12–L4   | Incomplete | -                     | -                         | 9 months, NER               |
| 10  | Yone et al.        | 1986 | 50/M    | T11–L4   | Incomplete | -                     | -                         | 13 months, NER              |
| 11  | Bursztyn and Prada | 1986 | 49/F    | L4–S1    | Complete  | -                     | +                         | NA                          |
| 12  | Shirasaki et al.   | 1988 | 44/F    | L4–S2    | Incomplete | +                     | +                         | 1 year, NER                 |
| 13  | Enomoto et al.     | 1991 | 60/M    | L1–S2    | Incomplete | -                     | -                         | 33 months, NER              |
| 14  | Enomoto et al.     | 1991 | 59/F    | L2–S2    | Incomplete | +                     | -                         | 1 year, NER                 |
| 15  | Kotoura et al.     | 1991 | 34/F    | S1–S3    | Incomplete | +                     | +                         | 5 years, NER, Intrasacral, RTx |
| 16  | Turk et al.        | 1992 | 41/M    | S2–S4    | Complete  | -                     | +                         | 18 months, NER, Intrasacral |
| 17  | Santi et al.       | 1993 | 48/M    | S1–S3    | Complete  | +                     | +                         | 33 months, NER, Intrasacral |
| 18  | Salvant and Young  | 1994 | 32/M    | NA       | Complete   | -                     | -                         | 18 months, NER, Intrasacral |
| 19  | Ortolan et al.     | 1996 | 27/F    | L5–S2    | Complete   | +                     | -                         | 17 months, NER, Intrasacral |
| 20  | Kagaya et al.      | 2000 | 57/F    | L3–S1    | Incomplete | +                     | -                         | 40 months, NER, Small ossification |
| 21  | Saito et al.       | 2004 | 65/F    | T12–L3   | Complete   | -                     | -                         | 18 months, NER, Dural ectasia |
| 22  | Türgut and Erkuş   | 2008 | 43/F    | L1–L5    | Incomplete | -                     | +                         | 3 years, +, Revision operation |
| 23  | Hung et al.        | 2008 | 53/M    | L1–L3    | Complete   | +                     | -                         | 6 months, NER               |
| 24  | Present case       | 2010 | 21/M    | L4–S2    | Complete   | -                     | -                         | 3 years, NER, Dystrophic calcification |

NA: not available, NER: no evidence of recurrence, RTx: radiation therapy
primary operation\textsuperscript{4,14,16}. However, tumors located in the lumbar spine region are usually incompletely excised because complete removal may risk the sacrifice of many nerve roots\textsuperscript{5}. An earlier review found that complete excision of such tumors frequently results in neurologic deterioration\textsuperscript{6}. In contrast, others have reported that the involved nerve roots were nonfunctional at the time of surgery and that the risk of neurologic deficit after sacrifice of such roots was thus small\textsuperscript{4,17}. Although the tumor described here was extensive in size, it involved only two nerve roots, which were shown to be non-functional at the time of surgery by both free-running and triggered EMG. This tumor could therefore be completely excised, with sacrifice of the (non-functional) roots giving rise to the tumor.

Giant schwannoma of the cauda equina often results in considerable vertebral erosion\textsuperscript{12}. In some previous reports, spinal fusion with instrumentation was performed after resecting a giant schwannoma to prevent vertebral fracture\textsuperscript{4,6}. We found that one-third of reported patients who underwent complete removal of giant schwannomas of the cauda equina required spinal reconstruction because of spinal instability. The patient described here had good bone quality, with a stable vertical column, and required only a laminoplasty using miniplates and screws. Moreover, the patient requested less invasive surgery. Fortunately, no vertebral fracture or instability has been seen in to three years postoperatively.

**CONCLUSION**

Giant schwannoma accompanied by dystrophic calcification is extremely rare. Such tumors can be safely and completely removed by meticulous dissection with neuromonitoring of the cauda equina spinal nerves involved in the tumor.

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