Incidence of Unrecognized Incidental Durotomy during Surgery for Malignant Spinal Tumor

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Abstract:

Introduction: Cerebral spinal fluid leak from durotomy is a well-known risk with spinal surgeries. The aim of this study is to identify the incidence of unrecognized incidental durotomy during posterior surgery for spinal metastases and its risk factors.

Methods: Participants comprised 75 patients who underwent posterior spine surgery for spinal metastases between January 2012 and December 2016. Cases with apparent durotomy noticed intraoperatively were excluded. Unrecognized durotomy was diagnosed as the presence of wide subcutaneous fluid retention on magnetic resonance imaging at least 3 months postoperatively. For comparison, 50 patients who underwent cervical laminoplasty due to cervical spondylotic myelopathy were examined using the same method. We also examined correlations between occurrence of durotomy and patient characteristics such as age, type of tumor, location of tumor (ventral or dorsal), extent of tumor, and history of radiotherapy before surgery.

Results: Unrecognized durotomy occurred in 21 cases of spinal metastasis (26.7%) and in 1 case of cervical spondylotic myelopathy (2%), representing a significant difference between groups. Age, type of tumor, location of tumor, extent of tumor, and history of radiotherapy before surgery did not correlate significantly with occurrence of durotomy. No local trouble was observed in durotomy cases, except in one case with subcutaneous local infection.

Conclusions: The incidence of unrecognized incidental durotomy is significantly higher during surgery for spinal metastases than that during surgery for degenerative disease.

Keywords:
unrecognized incidental durotomy, cerebrospinal fluid leak, malignant spinal tumor, complication

Introduction

Spinal metastasis is now a clinically challenging condition, with a morbidity rate of approximately 30%-70% among patients with cancer.1,2) Around 5% of cancer patients develop neurological deterioration during the clinical course.3) Some of these patients need surgery to accomplish decompression of the spinal cord and restoration of spinal stability.

Unintended durotomy during spinal surgery is a well-known complication, with a reported incidence of 1.6%-16%.4-6) In particular, cerebrospinal fluid (CSF) leak due to incidental durotomy during surgery for metastatic spinal tumor is a common complication, with a frequency of 3%-17%.2,7) somewhat higher than the incidence seen in general spine surgery.

Our hypothesis was that this higher incidence of durotomy is partly due to the adhesive, invasive nature of malignant tumors. Another hypothesis was that microscopic incidental durotomy and CSF leakage could occur during surgery for malignant spine tumor without being noticed intraoperatively. The aim of this study was thus to clarify the incidence of unrecognized incidental durotomy during surgery for malignant spine tumor.
Materials and Methods

Participants comprised 75 patients who underwent posterior spine surgery for spinal metastases at our hospital between January 2012 and December 2016. Operative procedures included posterior fixation using pedicle screws and rods and resection or curettage of tumor to achieve decompression of the spinal cord. Cases in which durotomy was noted intraoperatively were excluded. Unrecognized durotomy was diagnosed from wide subcutaneous fluid retention on magnetic resonance imaging (MRI) at least 3 months after surgery. The cases with fluid retention suspected of infection were excluded from this study.

For comparison, 50 patients who underwent spine surgery due to degenerative disease were examined using the same methods during the same period. We also examined the correlation between durotomy occurrence and the background characteristics of patients, such as age, type of tumor, location of tumor (ventral or dorsal), extent of tumor (Bilsky’s grade), history of radiotherapy before surgery, volume of postoperative drainage, and the characteristics of drainage (bloody or serous).

All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). More precisely, EZR is a modified version of R Commander designed to add statistical functions frequently used in biostatistics. Descriptive statistics were used to analyze clinical information, demographic factors, and other test data. Continuous variables are expressed as median and interquartile range. Differences between the groups were examined using Student’s t-test for continuous variables and the chi-square test for categorical data, as appropriate. Values of $P < 0.05$ were considered to indicate significant differences.

Results

Demographic data of patients included in this study are shown in Table 1. No significant difference was observed between two groups. As previously reported, metastases were most frequently seen in the thoracic spinal region.

Unrecognized durotomy was identified significantly more frequently among the cases of spinal metastasis (21 cases, 26.7%) than that among the cases of cervical spondylotic myelopathy (1 case, 2%; $P < 0.01$) (Table 2).

Age, sex, type of tumor, location of tumor, Bilsky’s grade, and history of radiotherapy before surgery showed no significant correlations with occurrence of durotomy (Table 3).

Similarly, volume of postoperative drainage did not differ between groups. Drainage characteristics (bloody or serous) also did not differ between groups. No local complications were observed in these cases with durotomy, except in one case with subcutaneous local infection. In that case, the infection was treated using antibiotics and resolved rapidly after two week treatment. No symptoms indicative of CSF leakage, such as headache, nausea, vomiting, or neck pain, were observed in these cases during the study period.

Illustrative case

A 63-year-old man with spinal metastases from prostate carcinoma to T9 presented at our hospital. He had a history of previous radiotherapy to the affected site 6 months before this admission. The tumor had relapsed and was strongly compressing the spinal cord (Fig. 1a, b). We performed posterior decompression and fixation surgery. Intraoperatively, no incidental durotomy or CSF leakage was noticed. The patient underwent stereotactic body radiotherapy after the surgery. Three months postoperatively, MRI of the thoracic spine showed massive fluid retention (Fig. 1c, d). However, the patient showed no sign of symptoms due to CSF leakage, such as headache, nausea, vomiting, or neck pain, were observed in these cases during the study period.

Discussion

In this study, unnoticed incidental durotomy was more frequent during surgery among patients with spinal metastases than that among patients with cervical degenerative disease. However, age, sex, type of tumor, location of tumor,
Table 3. Comparisons between Groups.

|                      | Durotomy (+) | Durotomy (−) | P-value |
|----------------------|--------------|--------------|---------|
| Age (years)          | 64 (52-70)   | 67 (58-72)   | 0.40    |
| Sex (male:female)    | 12:9         | 28:26        | 0.88    |
| Location             | 10:2:9       | 27:5:22      | 0.99    |
| Type of tumor        |              |              | 0.32    |
| Thyroid              | 6            | 19           |         |
| Kidney               | 2            | 7            |         |
| Colon                | 4            | 3            |         |
| Breast               | 3            | 2            |         |
| Lung                 | 1            | 4            |         |
| Multiple myeloma     | 2            | 3            |         |
| Other                | 3            | 16           |         |
| Bilsky’s grade       |              |              | 0.45    |
| 1b                   | 0            | 4            |         |
| 1c                   | 0            | 4            |         |
| 2                    | 7            | 16           |         |
| 3                    | 14           | 30           |         |
| History of radiotherapy (yes:no) | 6:15 | 19:35 | 0.76 |
| Postoperative drainage (mL) | 329 (250-576) | 329 (230-637) | 0.85 |
| Drainage characteristic (bloody:serous) | 16:5 | 44:10 | 0.85 |

Values represent median (interquartile range) or number of patients.

Figure 1. MRI sagittal (a) and axial (b) images of 63-year-old male with spinal metastases from prostate carcinoma at T9. The tumor is strongly compressing the spinal cord.

MRI sagittal (c) and axial (d) images of the same site 3 months postoperatively. Wide fluid collection is located from the epidural to subcutaneous level.
extent of tumor, and history of radiotherapy before surgery showed no significant correlations with frequency of durotomy.

Incidental durotomy could be associated with several postoperative complications, such as durocutaneous fistula, pseudomeningocele, arachnoiditis, intracranial hemorrhage, and surgical site infection. In particular, incidental durotomy during surgery for spinal metastasis could lead to intradural tumor recurrence because of local dissemination. Durotomy noticed intraoperatively is treated by primary closure and coverage with bioabsorbable sheet and fibrin glue. CSF leakage after surgery can lead to the above-mentioned complications.

Our study showed a higher incidence of wide subcutaneous fluid retention on MRI at least 3 months after metastatic spine surgery than that after surgery for cervical spondylotic myelopathy. Because the cases in which apparent incidental durotomy was noticed during surgery were excluded from this study, and fluid retention had remained for a certain period (≥3 months), we attributed fluid retention to unnoticed incidental durotomy and CSF leakage. Our hypothesis was that this higher incidence of such CSF leakage was due to the invasive and adhesive nature of the malignant tumors. Tumor adhesion to dura mater and procedures for dissection of adhesion during resection surgery could lead to incidental micro durotomy. We therefore expected that tumor location (ventral, dorsal, or circumferential and location relative to the spinal cord) would correlate with the occurrence of durotomy, because a dorsally located tumor would require more aggressive dissection of the tumor from the dura mater. Interestingly, location of the tumor showed no correlation with the occurrence of incidental durotomy. We also expected that a history of preoperative radiotherapy would correlate with the occurrence of durotomy. As previously reported, radiotherapy induces peridural fibrosis, and spine surgery after preoperative radiotherapy carries a high risk of incidental durotomy. However, in this study, a history of radiotherapy before surgery showed no correlation with the occurrence of incidental durotomy. The only factor that correlated with the frequency of incidental durotomy was the presence of a malignant tumor. However, the reason for these results remains unclear, since our hypothesis was rejected.

Fortunately, in this study, we encountered no symptoms or complications of CSF leakage, with the exception of one case of local subcutaneous infection. However, the results mean that the risk of hidden incidental durotomy during malignant spine surgery must be considered. Careful wound closure such as tight suturing of the fascia and skin might be suitable as a countermeasure.

Some limitations to this study must be considered. First, we considered that wide retention of subcutaneous fluid was due to CSF leakage following incidental durotomy, but no direct evidence of durotomy and CSF leakage was obtained in this study. One major differential diagnosis is old hematoma. But chronic hematoma typically shows low-signal intensity on T1- and T2-weighted MRI, which differs from our cases (Fig. 1c, d). Spinal myelography or radioisotope scintigraphy may provide direct evidence. Second, although a higher incidence of CSF leakage was observed, clinical outcomes in the cases in this study were not markedly affected, except in one case with subcutaneous soft-part infection. Preventive use of bioabsorbable sheets and fibrin glue when no incidental durotomy is apparent during surgery for spinal metastasis thus cannot be recommended from a cost-benefit perspective.

Third, as shown in Table 1, most of spinal metastasis occurred at thoracic level. Ideally, we had to use thoracic degenerative spinal disease cases as control. But we used cervical degenerative diseases as control, because degenerative thoracic spinal diseases were rarer than cervical diseases.

In conclusion, the incidence of unrecognized incidental durotomy is significantly higher during surgery for spinal metastases than that during surgery for degenerative disease.

Conflicts of Interest: The authors declare that there are no relevant conflicts of interest.

Author Contributions: Takuma Koyama and Shurei Sugita designed the study and wrote the initial draft of the manuscript. Shurei Sugita and Masanori Fujiwara contributed to analysis and interpretation of data and assisted in the preparation of the manuscript. All other authors have contributed to data collection and interpretation and critically reviewed the manuscript. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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