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Surgical Extent of Metastatic Spine Tumor Excision and Its Effects on Postoperative Ambulatory Function: Comparison of Extensive Wide versus Palliative Excision Surgery

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Study Design: Retrospective study.

Objectives: To compare surgical outcomes such as the ambulatory period and survival according to different surgical excision tactics for metastatic spine tumors (MSTs).

Summary of Literature Review: Surgical outcomes, such as pain relief and survival, in patients with MSTs have been reported in several studies, but the effects of differences in surgical extent on the ambulatory period have rarely been reported.

Materials and Methods: Ninety-six patients with MSTs who underwent palliative (n=60) or extensive wide excision (n=36) were included. Palliative excision was defined as partial removal of the tumor as an intralesional piecemeal procedure for decompression. Extensive wide excision was defined as a surgical attempt to remove the whole tumor at the index level as completely as possible. The primary outcome was the ambulatory period following surgery. Other demographic and radiographic parameters were analyzed to identify the risk factors for loss of ambulatory ability and survival. Perioperative complications were also assessed.

Results: The mean postoperative ambulatory period was longer in the extensive wide excision group (average 14.8 months) than in the palliative excision group (average 11.7 months) (p=0.021). The survival rates were not significantly different between the two surgical excision groups (p=0.680). However, postoperative ambulatory status and major complications within 30 days postoperatively were significant prognostic factors for survival (p=0.003 and p=0.032, respectively).

Conclusions: The extent of surgical excision affected the ambulatory period, and the complication rates were similar, regardless of surgical excision tactics. A proper surgical strategy to achieve postoperative ambulatory ability and to reduce perioperative complications would have a favorable effect on survival.

Key Words: Metastatic spine tumor, Surgical extent, Palliative, Wide, Ambulation

Introduction

The skeletal system is the third common site of cancer metastasis, following lung and liver, and the spinal column is the most common osseous site.[1)] In some cadaveric studies, 30~90% of patients whose cause of death was cancer were found to have spinal metastasis.[1)] A recent epidemiologic study about spinal metastasis in South Korea reported that the overall incidence rate of metastatic spine tumors (MSTs)

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was 25.96 per 100,000 persons with cancers.[2] Also, 10~30% of patients newly diagnosed with cancer exhibit symptomatic MSTs at presentation.[3] MSTs present with severe pain and neurologic deficits. As systemic therapy improves and the overall cancer survival time increases, the incidence of MSTs may rise proportionally.[4] Consequently, the treatment for MSTs has received great attention. Treatment goals for MSTs are, of course, to relieve pain, to restore neurologic function, and ultimately to improve quality of life (QOL).

The randomized trial by Patchell et al.[5] demonstrated that direct decompression surgery with postoperative radiotherapy for metastatic spinal cord compression showed better outcomes than radiotherapy alone. After this study, several surgical series reported that surgical treatment for spinal metastasis produced rapid pain relief, maintained ambulation, and improved QOL.[6-9] Some scoring systems help spine surgeons predict the instability of the spinal column and the survival of cancer patients, and thus, if surgery would provide better results for patients.[10-12] Although complete resection, such as total en bloc corpectomy, is occasionally performed in a limited number of cases, palliative decompression surgery is the standard strategy for MSTs.[13] However, surgeons often get confused about the extent of tumor removal. The purpose of this study was to compare the ambulatory period primarily, and additionally, survival and complication rates, according to the surgical extent in patients who underwent surgery for MSTs.

Materials and Methods

1. Patients

Institutional review board approval was obtained prior to beginning this study (IRB approval No. KC17RESI0442). The authors retrospectively investigated the patients who underwent surgical treatment for MSTs in the spine unit of a single institute between January 2011 and December 2015. All surgeries were conducted by a single surgeon (Y.H.K) and surgical indications were (1) progressive neurologic deficits, (2) intractable pain, (3) definite instability, and (4) a life expectancy of more than 6 months at the time of surgery (determined by oncologists). Solid cancer was included and metastatic lesions from hematologic malignancies such as multiple myeloma were excluded.

2. Surgical Treatment

Except in emergent situations, preoperative embolization was usually performed. All surgeries were performed via posterior-only approach. The surgical extent was determined preoperatively after full consultation with the Department of Oncology. According to the surgical extent, patients were subdivided into the following two groups: palliative decompression group (P) and extensive wide excision group (W). Based on the classification recommended by the Global Spine Tumor Study Group (GSTSG)[14], palliative decompression involves partial removal of the tumor as an intralesional piecemeal procedure for neural decompression. Extensive wide excision indicates an attempt to remove the tumor completely, regardless of whether piecemeal or en bloc excision is performed. In cases of wide excision involving the vertebral body, anterior support was provided using allogeneic fibular strut graft with or without a mesh cage. Instrumentation was performed in all cases, except for some sacral cases. The surgeon performed only palliative excision surgery in the first half of the study period and afterwards extensive wide excision surgery.

Postoperative management protocol was the same in both groups. Thoracolumbosacral orthosis (TLSO) was applied for 3 months. In patients who could walk with an aid, ambulation was encouraged since postoperative day 2. In patients who could not even stand, our department immediately requested the rehabilitation department to perform the ambulatory rehabilitation program. Adjuvant chemotherapy and radiotherapy were performed in selective patients determined by oncologists and radiotherapists. Regular follow-ups were performed at postoperative 1, 2, 3, 6, 9, and 12 months and annually thereafter.

3. Clinical Data

The primary outcome was the postoperative ambulatory period (in other words, time from surgery to loss of the ambulatory ability), and secondary outcomes were survival rates and complications rates. These outcomes were compared according to the surgical extent. Demographic data were collected by reviewing the medical records. We used our own modified version of Nurick ambulation grading system.[15] Grade 0, No difficulty in walking; Grade 1, Slight difficulty in walking, which needs no assistance; Grade 2, Difficulty in walking, which need assistance; Grade 3, Inability to walk, but can stand with assistance; Grade 4, Chair bound or bedridden. Ambulatory status was categorized as either ambulatory (Grade 0–2) or non-ambulatory (Grade 3 and 4). Preoperative and postoperative (within 30 days) ambulatory statuses were investigated. The postoperative ambulatory period was analyzed with use of the following parameters: age, gender (female vs. male), preoperative/postoperative ambulatory status (ambulatory or non-ambulatory), performance status, primary cancer, the responsiveness to preoperative chemotherapy (no chemotherapy, progressive disease, and stable disease/partial remission), and adjuvant radiotherapy to the index site (yes vs. no), American Society of Anesthesiologists (ASA) physical status classification (1–2 vs. 3–4), and preoperative serum albumin level ($<$3.0 g/mL vs. $\geq$3.0 g/mL). Axial pain and performance status were assessed using the visual analog scale (VAS) and the Eastern Cooperative Oncology Group (ECOG) scoring system, respectively. Blood loss during surgery ($<$2000 cc vs. $\geq$2000 cc), hospital stay, intensive care unit (ICU) care, and early postoperative complications (within 30 days after surgery) were compared between both groups.

4. Radiographic Data

Radiographic data were collected by reviewing the picture archiving and communication system (PACS). Plain radiographs, magnetic resonance imaging (MRI), and positron emission tomography (PET) were performed preoperatively in all patients. The number of metastatic spinal segments (1–2 vs. $\geq$3), extraspinal bone metastasis (yes vs. no), and visceral metastasis (yes vs. no) were recorded and analyzed. On axial MRI, the degree of epidural spinal cord compression (ESCC) was rated according to the ESCC scale by Bilsky et al.[16]

5. Statistical Analysis

The baseline demographic and radiographic data were compared between the P and W groups using the Student t-test or Mann-Whitney test for continuous variables and chi-square test or linear by linear test for categorical variables. Kaplan-Meier curve for the ambulatory period was obtained, and log-rank test was performed to compare the ambulatory survival rate between both groups. Univariate analysis was performed using Cox hazards proportional model to identify the factors correlated with the maintenance of the ambulatory ability. The variables that maintained $p<0.2$ in univariate analysis were entered into multivariate analysis. A P value of $<$0.05 was considered statistically significant. In the same manner, risk factor analysis for survival was also performed. Statistical analysis was performed using SPSS software (version 21.0.0; SPSS Inc, Chicago, IL, USA).

Results

The study cohort included 62 males and 34 females with a mean age of 57.1±12.8 years (range, 21~86 years) at the time of surgery. The most common primary cancer was lung cancer (n=35, 36.5%), followed by hepatobiliary cancer (n=25, 26.0%) (Fig. 1). Sixty patients underwent palliative curettage (P group) and thirty-six patients underwent extensive wide excision (W group). Fifty patients had extraspinal bony metastasis, 68 patients had visceral metastasis, and 31 patients had both extraspinal bony and visceral metastases. Thirty-two patients had oligometastatic spinal disease (metastatic segments $\leq$2). Preoperative embolization was performed in 45 patients. Preoperative patient data are summarized in Table 1. The ESCC scale on preoperative MRI is described in Table 2. The median follow-up period was 5 months (95% CI, 0–32 months). The data about the preoperative/postoperative chemotherapy and radiotherapy are summarized in Table 3.

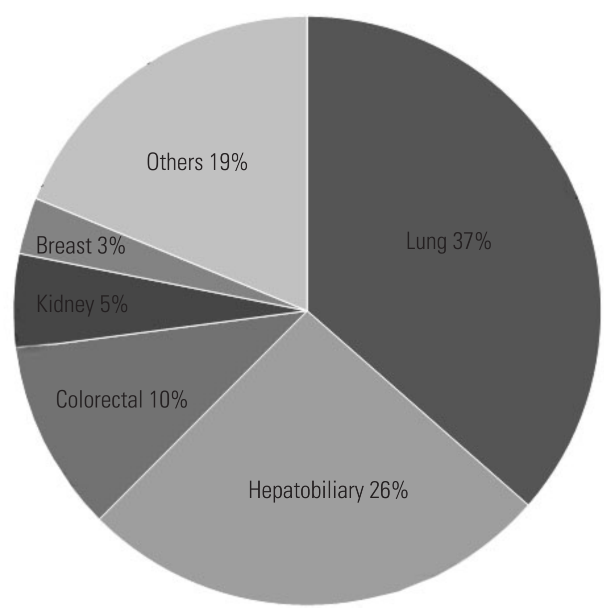

Fig. 1. Distribution of primary solid cancers.
The most common primary cancer was lung cancer (n=35, 36.5%), followed by hepatobiliary cancer (n=25, 26.0%).

Table 1. Summary of preoperative patient data

	Total (n=96)	P group (n=60)	W group (n=36)	p
Age (range)	57.1±12.8(21-86)	56.2±13.4(21-86)	58.6±11.6(23-79)	NS*
Male (n, [%])	62(64.6)	46(76.7)	16(44.4)	0.001†
Surgical level				
Cervical	10	4	6	
Thoracic	56	36	20	NS‡
Lumbosacral	30	20	10	
Tumor diagnosis to surgery, median (month)	11.0(0-170)	11.0(0-154)	12.0(1-170)	NS¶
Symptom to surgery, median (day)	24.5(0-330)	21(1-240)	36.5(0-330)	NS$
Metastasis (n)				
None	9	6	3	
Non-spinal bone	19	15	4	NS‡
Visceral	37	21	16	
Both	31	18	13	
No. of metastatic spine segments (n)				
1-2	32	17	15	NS†
≥3	64	43	21	
Preop. ECOG-PS (n)				
1	39	22	17	
2	25	11	14	NS‡
3	25	20	5	
4	7	7	0	
Ambulatory (n, [%])	73(76.0)	41(68.3%)	32(88.9%)	0.022†
ASA physical status classification (n)				
1-2	75	50	25	NS†
3	21	10	11	
Preop. serum albumin (g/dL)	3.4±0.5	3.4±0.5	3.6±0.6	0.010*
≥3.0 (n)		50	30	NS†
<3.0 (n)		10	6	
Preop. embolization (n)	45	19	26	<0.001

ECOG-PS: the Eastern Cooperative Oncology Group-Performance Status, AS: American Society of Anesthesiologist, NS: not significant.
*Student t-test, †Chi-square test, ‡lineary by linear test, and $Mann-Whitney test were performed.

1. Clinical Outcomes

VAS decreased significantly in both groups after surgery (7.7 to 4.3 in P group, p=0.014; 7.3 to 3.6 in W group, p=0.011). Preoperatively, 73 patients were ambulatory, and 23 patients were non-ambulatory. Within postoperative 30 days, 4 patients (all in the P group) became ambulatory from non-ambulatory, and 3 patients (2 in the P group, 1 in the W group) became worse in terms of their ambulatory ability after surgery. Overall, patients had kept themselves ambulatory for 14.3±1.5 months after surgery (median, 13.0; 95%

Table 2. Epidural cord compression scale on MRI suggested by Bilsky et al.[21]

	Total (n=96)	P group (n=60)	W group (n=36)	p*
0	7(7.3%)	4(6.7%)	3(8.3%)	NS
1	19(19.8%)	11(18.3%)	8(22.2%)	
2	19(19.8%)	10(16.7%)	9(25%)	
3	51 (53.1%)	35(58.3%)	16(44.5%)	

NS: not significant.
*Linear by linear test was performed.

Table 3. Summary about preoperative and postoperative chemotherapy/radiotherapy

	P group (n=60)	W group (n=36)	p*
Postop. RT	33(55%)	27(75%)	NS
Preop. CT	32(53.3%)	19(52.8%)	
PD	23	15	NS
SD or PR	9	4	
Postop. CT	27(45%)	21(58.3%)	NS

Postop: postoperative, RT: radiotherapy, CT: chemotherapy, PD: progressive disease, SD: stable disease, PR: partial remission, NS: not significant.
*Chi-square test was performed.

confidence interval [CI], 11.4~17.3). During follow-up, loss of the ambulatory capacity was observed in 8 patients and 26 patients in the W and P groups, respectively. Patients in the W group could walk for an average of 14.8±1.5 months after surgery (95% CI, 11.9~17.7), and patients in the P group could walk for an average of 11.7±1.7 months after surgery (95% CI, 8.3~15.0). The ambulatory survival rate was longer in the W group than in the P group (p=0.021, Fig. 2). Whereas the causes of non-ambulatory status were tandem spine metastasis (n=3) or chronic illness (n=5) in the W group, the causes in the P group were neurologic deterioration at the index level (n=11) as well as femur fracture (n=3) and chronic illness (n=11). On univariate analysis, extensive wide excision was a significant factor for longer ambulatory capacity. On multivariate analysis with factors showing p<0.2 on univariate analysis, the extent of surgical excision remained the only significant factor (Table 4).

2. Survival

Overall 6-month and 1-year survival rates were 62.8% and 40.3%, respectively (median, 9 months). The median survival time was 8 months (range, 0~32 months) in the P group and 10 months (range, 0~22 months) in the W group. A log-rank test indicated that both groups showed no significant difference in the survival rate (p=0.680, Fig. 3). Although surgical excision did not have a significant correlation with survival (p=0.689), early postoperative ambulatory status and perioperative major

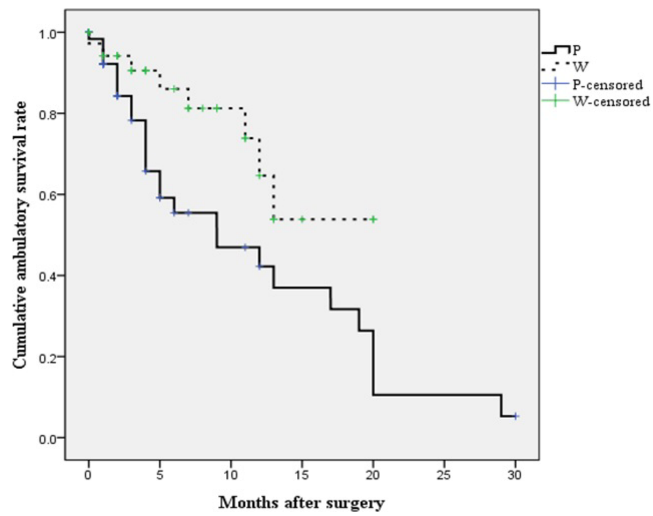

Fig. 2. Kaplan-Meier curve of the postoperative ambulatory period according to the extent of surgical excision.
Patients in the W group could walk for an average of 14.8±1.5 months after surgery (95% CI, 11.9-17.7 months), and patients in the P group could walk for an average of 11.7±1.7 months after surgery (95% CI, 8.3-15.0 months). Surgical extent significantly affected the postoperative ambulatory period (p=0.021).

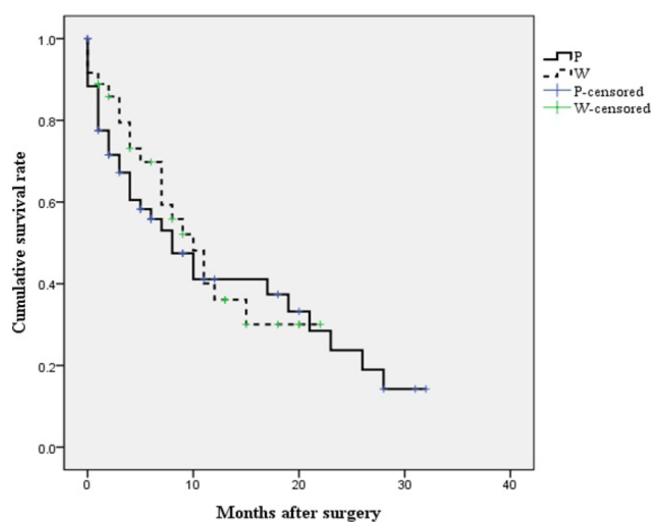

Fig. 3. Kaplan-Meier curve of the survival rate according to the extent of surgical excision.
Surgical extent did not affect the survival rate (p=0.689).

Table 4. Risk factor analysis for ambulatory outcome

	Loss of ambulatory status during follow-up			Survival*		
	P for univariate analysis	P for multivariate analysis	HR (95% CI)	P for univariate analysis	P for multivariate analysis	HR (95% CI)
Sex	0.288			0.886		
Age (≥60 vs. <60 y)	0.128	0.589		0.740		
Location of metastasis	0.407			0.911		
Wide excision vs. Palliative excision	0.030	0.034	0.418(0.187-0.935)	0.689		
Adjuvant RT (Yes vs. No)	0.441			0.007	0.191	
Preop. CT (No vs. PD or SD/PR)	0.056	0.170		0.362		
Postop. CT (Yes vs. No)	0.333			0.486		
Preop. ECOG-PS (1-2 vs. 3-4)	0.583			0.002	0.499	
Preop. ambulatory (Yes vs. No)	0.264			<0.001	0.951	
Postop.(within 30d) ambulatory (Yes vs. No)	0.602			<0.001	0.003	2.675(1.408-5.083)
ASA (1-2 vs. 3-4)	0.358			0.578		
ESCC scale (0-1 vs. 2-3)	0.470			0.268		
Number of metastatic spine (1-2 vs. ≥3)	0.307			0.795		
Extraspinal bone metastasis (Yes vs. No)	0.343			0.480		
Visceral metastasis (Yes vs. No)	0.280			0.233		
Preop. serum albumin (<3.0 vs. ≥3.0 g/dL)	0.072	0.675		0.857		
Intraop. bleeding (≥2000 vs. <2000 cc)	0.377			0.908		
Perioperative major complication (Yes vs. No)	0.120	0.129		0.003	0.032	0.491 (0.256-0.940)

Preop: preoperative, RT: radiotherapy, CT: chemotherapy, PD: progressive disease, SD: stable disease, PR: partial remission, ECOG-PS: the Eastern Co-operative Oncology Group-Performance Status, ASA: American Society of Anesthesiologist, ESCC: epidural cord compression, HR:hazard ratio, CI: confidence interval, N/A: not applicable.
*Cox bioharzard proportional model was performed.

complications (within postoperative 30 days) were significant prognostic factors for survival (Table 4).

3. Surgery-related data and Complications

Intraoperative mean blood loss was 1,176±1,857 mL and 1,147±1,270 mL in the P and W groups, respectively. However, there was no association between blood loss and preoperative embolization (1,181±1,992 mL without embolization and 1,147±1,194 mL with embolization, p=0.923). Mean operation time was 229.8±85.0 minutes and 288.7±92.7 minutes in the P and W groups, respectively. Hospital stay was 25.0±17.9 days and 27.9±15.3 days in the P and W groups, respectively. ICU care was required in 26 patients (43.3%) and 18 patients (50%) of the P and W groups, respectively. Major complications within a postoperative 30-day period occurred in 15 patients (25%) and 8 patients (22.2%) in the P and W groups, respectively. The number of patients who died within a postoperative 30-day period was 7 in the P group (11.7%) and 3 in the W group (8.3%) (Table 5).

Discussion

Limited number of cases have shown that treatment of MSTs might result in long-term disease-free survival[11,17]; however, the primary treatment goal for MSTs is "to walk and live their life", namely maintenance or improvement of QOL.[18] Among

Table 5. Perioperative complications analysis (within postoperative 30-day)

	Total (n=96)	P group (n=60)	W group (n=36)	P*
Total	23	15	8	
Pneumonia	9	6	3	
Wound problems	7	4	3	
Thromboembolism	3	3	0	NS
GI bleeding	2	1	1	
Sepsis	3	1	2	
CVA	1	1	0	
Death	10	7	3	NS

GI: gastrointestinal, CVA: cerebrovascular accident, NS: not significant.
*Chi-square was performed.

the various factors affecting QOL, ambulation is one of the most important factors and that is why many authors have conducted researches on post-treatment ambulatory status and several QOL assessment tools, such as EQ-5D, contain items related to ambulatory ability.[19,20] Considering the symptoms of MSTs, decompression and stabilization should be achieved for neural compressive status and spinal instability, respectively. Decompression is usually performed by excision of the tumor mass compressing the neural tissue. A variety of surgical techniques have been reported: posterior decompression with or without stabilization, minimally invasive decompression with or without stabilization, transpedicular corpectomy with stabilization, and anterior corpectomy with posterior stabilization. Although heterogeneous primary tumors were included and surgical techniques were different in previous studies, systematic reviews reported that pain, neurologic status, QOL, and even mortality had improved.[13]

However, there are little studies comparing surgical outcomes according to the extent of surgical tumor excision for MSTs. Recently, de Ruiter et al.[21] compared the change of neurologic status and QOL with use of Frankel scores and EQ-5D, respectively, among various surgical procedures (decompression with stabilization, corpectomy, and stabilization alone) in a prospective cohort of 113 patients with spinal metastasis, and they reported no significant difference in improvement in EQ-5D scores and Frankel grades among procedures. They analyzed the results based on the procedure; however, we adopted the classification proposed by the Global Spine Tumour Study Group (GSTSG) and analyzed surgical outcomes of patients with MST based on this classification.[14]

When spinal cord or cauda equina compression corresponding to Bilsky's ESCC scale of 2 or more on MRI was defined as significant compression, most of the patients (75% in the P group and 69% in the W group) showed significant compression. Patients with more extensive excision of the metastatic tumor (W group) sustained their ambulatory status significantly longer than patients with palliative decompression (P group). On the other hand, the authors had expected that more perioperative complications would develop after invasive and extensive surgery; however, the complication rates were not different between both groups. This interesting result suggests that spine surgeons should keep in mind that aggressive procedures for improving the quality of life should be considered in patients with MST, if the life expectancy is not too short. Kim et al.[22] reported that one-stage posterior corpectomy had no significant advantage over decompression with fusion. Their study showed a conflicting result from the current study. As described in their report, they performed corpectomy without aggressive circumferential decompression, and this might be the reason why a different result was obtained compared to that in the current study.

Survival rate in this study showed no difference between both groups. However, non-ambulatory status at the early postoperative period and perioperative major complications were significant risk factors for survival in all patients. Previous studies have already demonstrated that postoperative ambulatory status was the prognostic factor for survival time in patients with MST.[23,24] Although statistical analysis did not show a direct association between surgical tactics and survival, the authors believed that an attempt to improve and prolong the postoperative ambulatory status with more extensive excision of MST might help to achieve longer survival in patients with MST.

Because extensive wide excision requires more time for tumor removal than palliative excision, the operation time in the W group was significantly longer than that in the P group in this study. However, against the authors' expectation, intraoperative blood loss between both groups was not different. Perioperative major complications occurred in 28.1% (27/96) of the patients and complication rates were not different between both groups. More extensive surgery could have resulted in more perioperative complications including death during the perioperative period; however, this study did not show such a difference. In a large prospective cohort study performed by the GSTSG, intraoperative and postoperative complications and 30-day mortality were not higher in the more extensive surgery group.[6] This might have resulted from the preoperative overall condition of patients. Because perioperative complications affected the survival time, spine surgeons should make an effort to reduce these complications.

This study has an inherent limitation as it is a retrospective review. Another major limitation of this study is the lack of objective criteria for classifying the surgical extent. Although all wide excision procedures should have been performed as en bloc vertebrectomy for its surgical purpose, as originally expressed by Boriani et al.[25], most of the cases, the piecemeal technique was performed in this study. Moreover, the bias might have been introduced by loss to follow-up because some of the patients had been transferred to the secondary institutes for recuperation. Also, the ambulatory ability is one of the important factors in QOL; however, objective assessment tools for QOL, such as EQ-5D, were not included in this study. And the preoperative ambulatory status was not similar between two groups (68.3% vs 88.9%). It might influence the postoperative ambulatory status. Another critical limitation is the heterogeneity in the included patients. First, the origin of primary solid cancer was heterogeneous. Different solid cancers show different clinical courses[9,11,12,24], and thus, metastatic spine tumors of different origins could have different clinical features. Even though the authors underwent same and enough decompression, the mass effect of tumor could be the additional decompressive effect that leads to better ambulatory outcomes in W group. On the other side, tumor recurrence could be frequent in P group and it could be the factor of poor ambulatory outcomes. Second, this study analyzed MST at different levels altogether.

Nevertheless, this report is meaningful as it is the first study to demonstrate that the postoperative maintenance of ambulatory status might depend on the extent of surgical excision. This study could be helpful for spine surgeons in determining surgical tactics for metastatic spine tumors.

Conclusions

After more aggressive wide surgical excision of metastatic spine tumors, the ambulatory ability could be maintained for a longer period and the postoperative complication rate was not higher than that after less aggressive palliative surgery. Although this study did not prove a direct correlation between surgical tactics and survival time, the postoperative ambulatory status had a favorable effect on survival. Based on this result, spine surgeons and patients with MST should choose the most appropriate surgical tactic.

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전이성 척추 종양의 절제 범위에 따른 술 후 보행 기능: 광범위 절제술과 고식적 절제술의 비교

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연구 계획: 전이성 척추 종양 환자를 후향적 연구로 분석하였다.

목적: 척추 전이암 환자들의 수술 범위에 따른 임상 경과에 대해 연구를 통하여 보행 가능 기간 그리고 생존 기간에 대한 임상적 결과를 비교하고 분석하였다.

선행 연구문헌의 요약: 전이성 척추 종양 환자들의 동통 감소, 생존 기간에 대한 임상 결과에 대해서는 여러 연구에서 보고되었지만, 수술 범위에 따른 보행 가능 기간에 대한 연구는 거의 보고된 적이 없는 실정이다.

대상 및 방법: 2011년 1월부터 2015년 12월까지 척추 전이암 환자들 중, 수술적 치료를 시행한 96명을 연구 대상으로 하였으며, 고식적 절제술을 받은 60명과 광범위 절제술을 받은 36명으로 나누어서 비교하였다. 두 군간의 임상 결과는 수술 후 보행 기간, 생존율, 술 후 합병증 등을 이용하여 평가하였다.

결과: 수술 후 보행 기간은 광범위 절제술을 받은 군에서 평균 14.8개월 그리고 고식적 절제술을 받은 군에서 11.7개월로 광범위 절제술 받은 군이 고식적 절제술을 받은 군보다 통계학적으로 유의하게 나은 결과를 보였으나(p=0.021), 두 군간의 생존율에서는 유의한 차이가 없었다(p=0.680). 그러나 술 후 보행 상태와 1개월 이내의 수술 후 합병증은 생존율의 유의한 예측 인자로 분석되었다(p=0.003, p=0.032).

결론: 전이성 척추 종양의 치료에서 수술적 절제 범위는 수술 후 보행 기간과 연관성이 높았다. 비록 수술 방법과 생존 기간 사이에 연관성은 없었으나, 적절한 수술 방법을 선택함으로서 수술 후 보행 능력 유지 및 술 후 합병증 감소에 우월한 효과를 얻을 수 있을 것으로 생각된다.

색인 단어: 전이성 척추 종양, 절제 범위, 고식적 절제, 광범위 절제, 보행 기간

약칭 제목: 전이성 척추 종양의 광범위 절제술과 고식적 절제술의 비교

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