Postoperative survival and functional outcomes for patients with metastatic gynecological cancer to the spine: case series and review of the literature

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OBJECTIVE Spinal metastases from gynecological cancers are rare, with few cases reported in the literature. In this study, the authors examine a series of patients with spinal metastases from gynecological cancer and review the literature.

METHODS The cases of 6 consecutive patients who underwent spine surgery for metastatic gynecological cancer between 2007 and 2012 at a single institution were retrospectively reviewed. The recorded demographic, operative, and postoperative factors were reviewed, and the functional outcomes were determined by change in Karnofsky Performance Scale and the American Spine Injury Association (ASIA) score during follow-up. A systematic review of the literature was also performed to evaluate outcomes for patients with similar gynecological metastases to the spine.

RESULTS In this series, details regarding metastatic gynecological cancers to the spine are as follows: 2 patients with cervical cancer (both presented at age 46 years, mean postoperative survival of 32 months), 2 patients with endometrial cancer (mean age of 40 years, mean postoperative survival of 26 months), and 2 patients with leiomyosarcoma (mean age of 44 years, mean postoperative survival of 20 months). All patients presented with pain, and no complications were noted following surgery. All patients with known follow-up had stable or improved neurological outcomes, performance status, and improved pain, without local recurrence of tumor. Overall median survival after diagnosis of metastatic spine lesions for all cases in the literature as well as those treated by the authors was 15 months. When categorized by type, median survival of patients with cervical cancer (n = 2), endometrial cancer (n = 26), and leiomyosarcoma (n = 16) was 32, 10, and 22.5 months, respectively.

CONCLUSIONS Gynecological cancers metastasizing to the spine are rare. In this series, overall survival following diagnosis of spinal metastasis and surgery was 27 months, with cervical cancer, endometrial cancer, and leiomyosarcoma survival being 32, 26, and 20 months, respectively. Combined with literature cases, survival differs depending on primary histology, with decreasing survival from cervical cancer (32 months) to leiomyosarcoma (22.5 months) to endometrial cancer (10 months). Integrating such information with other patient factors may more accurately guide decision making regarding management of such spinal lesions.

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KEY WORDS spine; metastasis; endometrial carcinoma; cervical cancer; leiomyosarcoma; surgery; tumor; gynecological; oncology

ABBREVIATIONS ASIA = American Spine Injury Association; DVT = deep vein thrombosis; KPS = Karnofsky Performance Scale; UTI = urinary tract infection.

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IN the United States, the estimated incidence of gynecological cancer is approximately 11%,³² with 71,500 new diagnoses and 26,500 deaths each year.⁷ The 3 most common types are uterine (53%), ovarian (25%), and cervical (14%).³² Management depends on the site and extent of disease but typically involves a combination of surgery, chemoradiation, and hormone therapy. Ovarian cancer carries the poorest prognosis with a 5-year survival of 44.6% as compared with 67.9% for cervical cancer and 81.5% for endometrial cancer.^{25–27} Leiomyosarcoma is a rare, malignant connective tissue tumor originating from smooth muscle cells⁸ and most frequently arises in the uterus, gastrointestinal tract, or retroperitoneum.³¹ Due to its high rate of metastatic recurrence and resistance to radiation and chemotherapy, prognosis is poor.

Metastasis of gynecological cancers varies depending on the type. Cervical cancer, endometrial cancer, and leiomyosarcoma most commonly metastasize to the lung and liver,^{16,22} while ovarian cancer spreads locally within the peritoneum and pelvis.²⁰ Bone metastases are seen more commonly in cervical cancer but are infrequent in endometrial cancer and leiomyosarcoma. Among bone metastases, the spine is a common site; however, due to the rarity of this occurrence, surgical management of spinal metastases has not been well described. We retrospectively reviewed the medical records of patients who underwent surgery for spinal metastases of gynecological cancer at our institution and performed a literature review to identify other published reports to obtain more accurate prognostic information on such rare lesions.

Methods

Case Series

After obtaining approval from the institutional review board, a database of patients who underwent spine surgery for metastatic cancer from 2007 to 2012 at our institution was screened, and 6 patients were identified with primary tumors of gynecological origin that metastasized to the spine. Medical, imaging, and operative records for each of these patients were retrospectively reviewed.

Demographic factors, including age, race, smoking history, and comorbidities were reviewed. Additionally, prior cancer history, preoperative interventions, operative approach and techniques, postoperative factors, interventions, adjuvant therapies, functional outcome, and survival were assessed. The prior cancer history included primary tumor histological diagnosis, time from primary diagnosis, history of adjuvant therapies (chemotherapy, radiotherapy, etc.), time to diagnosis of spinal metastasis, and presenting symptoms. Operative factors included indication for surgery, type of surgical procedure, approach, instrumentation, levels involved, vertebrectomy, intraoperative complications, and estimated blood loss. Postoperative factors included need for blood transfusion, hospital length of stay, discharge location, adjuvant treatment, local recurrence, and survival. Functional outcome was determined by change in Karnofsky Performance Scale (KPS) score, and neurological outcome was evaluated by change in the American Spine Injury Association (ASIA) score.

Literature Review

A review of the literature was performed using PubMed as well as a review of the bibliographies of eligible articles. The search string employed for cervical cancer was (“uterine cervical neoplasms”[MeSH Terms] OR (“uterine”[All Fields] AND “cervical”[All Fields] AND “neoplasms”[All Fields]) OR “uterine cervical neoplasms”[All Fields] OR (“cervix”[All Fields] AND “cancer”[All Fields]) OR “cervix cancer”[All Fields]) AND (“spine”[MeSH Terms] OR “spine”[All Fields]) AND (“neoplasm metastasis”[MeSH Terms] OR (“neoplasm”[All Fields] AND “metastasis”[All Fields]) OR “neoplasm metastasis”[All Fields] OR “metastasis”[All Fields])). The search string for endometrial cancer was (“endometrial neoplasms”[MeSH Terms] OR (“endometrial”[All Fields] AND “neoplasms”[All Fields]) OR “endometrial neoplasms”[All Fields] OR (“endometrial”[All Fields] AND “cancer”[All Fields]) OR “endometrial cancer”[All Fields]) AND (“spine”[MeSH Terms] OR “spine”[All Fields]) AND (“neoplasm metastasis”[MeSH Terms] OR (“neoplasm”[All Fields] AND “metastasis”[All Fields]) OR “neoplasm metastasis”[All Fields] OR “metastasis”[All Fields])). For Leiomyosarcoma, we used (“leiomyosarcoma”[MeSH Terms] OR “leiomyosarcoma”[All Fields]) AND (“spine”[MeSH Terms] OR “spine”[All Fields]) AND (“neoplasm metastasis”[MeSH Terms] OR (“neoplasm”[All Fields] AND “metastasis”[All Fields]) OR “neoplasm metastasis”[All Fields] OR “metastasis”[All Fields])).

Criteria for inclusion were articles written in English or those having an English translation; articles describing patients with confirmed gynecological leiomyosarcoma, endometrial cancer, or cervical cancer and metastases to the spine; and fully published, peer-reviewed studies including randomized controlled trials, nonrandomized trials, cohort studies, case control studies, case series, and case reports. Criteria for exclusion were articles with no extractable data specific to metastatic spine disease, articles looking at primary spine tumors, and studies of cases with unconfirmed primary tumor pathology.

Statistical Analysis

Survival statistics and Kaplan-Meier curves were calculated using GraphPad Prism 5.0. Cases from the literature as well as our institution were included. Cases with unknown follow-up or survival times were excluded from the analysis.

Results

Summary of Cases

Our series (Table 1) consisted of 2 patients with cervical cancer (both presented at age 46 years, mean postoperative survival of 32 months), 2 patients with endometrial cancer (mean age of 40 years, mean postoperative survival of 26 months), and 2 patients with leiomyosarcoma (mean age of 44 years, mean postoperative survival of 20 months). There were no patients with metastatic ovarian cancer to the spine. None of the patients had other medical comorbidities, although 3 patients had a smoking history. Only 1 patient had undergone prior radiation therapy for her primary tumor; none of the women received preop-

TABLE 1. Individual characteristics of 6 patients with gynecological metastases to the spine

Case No.	Cancer Type	Patient Presentation	Neurologic Exam	Time to Spine Metastasis (yrs)	Primary Tumor Treatment	Other Metastases at Time of Surgery	Spine Location	MRI Findings
1	Cervical	37-yo F w/ back pain	NI	0	None	Lymph node, mediastinum, retroperitoneum	T-6	T-6 lesion w/ epidural extension & collapse of VB w/ fracture
2	Cervical	54-yo F w/ 1 mo of worsening back pain, tingling & numbness of leg	3 of 5 strength in iliopsoas; otherwise NI	0	None	None	L1-2	Lesion at L1-2 compromising thecal sac
3	Endometrial	32-yo F w/ 1.5 yrs of lt LE pain	NI	4	Hyst & BSO	None	L2-3	Lytic lesion at L-2 causing compression of thecal sac
4	Endometrial	48-yo F w/ recent neck pain	NI	1	Resection, chemoradiation, tamoxifen	None	T-1	Pathologic fracture w/ expansile lesion at T-1
5	Leiomyosarcoma	41-yo F w/ progressive rt hip pain leading to imaging findings of spinal mets	NI	2	Hyst w/o BSO	Lung, iliac bone	C5-7; L-4	Compression at C-6, compression at L-4 w/ epidural extension
6	Leiomyosarcoma	47-yo F w/ 1 mo history of back pain	NI	4	Hyst	Lung, liver	T-9	Lesion at T-9 w/ epidural & CC

BSO = bilateral salpingo-oophorectomy; CC = cord compression; Hyst = hysterectomy; LE = lower-extremity; met = metastasis; NI = neurologically intact; VB = vertebral body; yo = year-old.

erative chemotherapy or neoadjuvant radiotherapy to the spine. All patients presented with focal spine pain, with 1 patient having concurrent paresthesias and another having concurrent motor weakness and gait difficulties. All patients had a preoperative ASIA score of D or E.

Metastases were most commonly located in the thoracic spine (n = 5, 83%) and were also seen in the cervical spine (n = 1, 17%) and lumbar spine (n = 3, 50%). Indications for surgery included cord compression alone (n = 2, 33%), instability and cord compression (n = 3, 50%), and severe pain (n = 1, 17%). The 6 patients underwent a total of 8 surgeries, and all underwent tumor resection and spinal fusion (Table 2). Four patients underwent a single surgery. One leiomyosarcoma patient underwent an additional staged surgery for new spinal metastases, and 1 patient with cervical cancer underwent a staged procedure. Median blood loss for cervical cancer, endometrial cancer, and leiomyosarcoma was 200, 2425, and 550 ml, respectively. No intraoperative complications were noted, and postoperative complications included DVT, atelectasis, UTI, and intractable pain. No patients experienced instrument failure, required postoperative blood transfusion, or required revision. Median hospital stay was 7 days (range 3–9 days). Four patients were discharged to home and 2 were discharged to inpatient rehabilitation.

All 5 patients with follow-up had improvement or complete resolution of their pain postoperatively. Baseline KPS and ASIA scores remained stable or improved in 5 patients (83%) but was unknown in 1 patient at last follow-up (patient died 6 months after surgery). One patient received no postoperative adjuvant treatment and 5 patients received adjuvant radiation. As seen in Table 3, the total dose ranged from 3000 cGy to 3750 cGy. No patients had local recurrence of tumor as evaluated on MRI. Mean postoperative survival for leiomyosarcoma, endometrial cancer, and cervical cancer was 20, 26, and 32 months, respectively, with 2 patients (endometrial, cervical) alive at 28 and 37 months postoperatively (Table 4).

Literature Review

For patients with cervical cancer, a total of 3 articles described a total of 13 cases of metastasis to the spine (Table 5). Median age at presentation was 53 years (range 30–84 years). The lumbar spine was the most common location of metastasis (10 of 13). Treatment and time to follow-up was reported for only 1 patient, who received chemoradiation and survived a few months. Only 6 (46%) of 13 patients were alive at last follow-up.

For patients with endometrial cancer, 6 articles described a total of 25 cases of metastasis to the spine (Table 6). Median age at presentation was 62 years (range 47–80 years). Of the 16 cases with described metastasis location, the most common location involved was the thoracic spine (7 of 16), followed by the sacrum (6 of 16). Two patients were treated surgically: 1 patient underwent a sacrectomy through a posterior approach from S2, with en bloc excision of metastasis, and the other patient underwent T12 vertebrectomy and anterior spinal fusion. Of the 24 patients with known survival, median survival was 9 months (range 1–199 months). The 1-year and 5-year survival rates were 38% and 8.3%, respectively. Only 4 patients (16%)

TABLE 2. Patient operative characteristics

Cancer Type	Total Surgeries	Indication for Surgery	Surgery Description	Staged	Approach	Instrumentation	Vertebrectomy	EBL (ml)
Cervical	1	Instability & CC	T-6 vertebrectomy w/ tumor resection, & arthrodesis	No	Anterior	Yes	Yes	200
Cervical	1	Instability & CC	Stage 1: T11–L3 laminectomy & arthrodesis w/ L1–2 tumor resection; Stage 2: L1–2 vertebrectomy, T12–L3 anterior reconstruction, & arthrodesis	Yes	Anterior & posterior	Yes	Yes	200
Endometrial	1	CC	L1–3 laminectomy, L2–3 vertebrectomy, T11–L5 arthrodesis	No	Posterior	Yes	Yes	4000
Endometrial	1	Severe pain	T-1 corpectomy w/ C6–T2 discectomy & arthrodesis	No	Anterior	Yes	Yes	850
Leiomyosarcoma	3	CC	C5–7 laminectomy w/ tumor resection; C5–7 posterior cervical segmental fixation	No	Posterior	Yes	No	NK
		CC	Stage 1: L-4 corpectomy, tumor resection, & decompression w/ L3–5 anterior lumbar fusion	Yes	Anterior	Yes	Yes	800
		CC	Stage 2: L2–5 arthrodesis	Yes	Posterior	Yes	No	400
Leiomyosarcoma	1	Instability & CC	T-9 vertebrectomy w/ tumor resection, T8-T10 arthrodesis, & spinal reconstruction	No	Anterior	Yes	Yes	300

EBL = estimated blood loss.

TABLE 3. Patient postoperative characteristics

Case No.	Cancer Type	Total Surgeries	Postop Complication	LOS (days)	Discharge Location	Postop Adjuvant Therapy*	Total Radiation Dose (cGy)	Radiation Treatment Summary	Levels Treated
1	Cervical	1	DVT	8	Home	RT	3500	250 cGy per day in 14 fractions to 100% isodose line	T4–8
2	Cervical	1	None	8	Inpatient rehab	RT	3000	273 cGy per day in 11 fractions to 95% isodose line	T11–L4
3	Endometrial	1	None	5	Inpatient rehab	RT	3750	250 cGy per fraction in 15 fractions delivered to 100% isodose line	T12–L4
4	Endometrial	1	Atelectasis	6	Home	RT	NK	NK; treatment at outside hospital	NK
5	Leiomyosarcoma	3	None	3	Home	RT	3000	10 fractions; further details NK; treatment occurred at outside hospital	NK
			None	10	Home				
			None	10	Home				
6	Leiomyosarcoma	1	Intractable postop pain; UTI	9	Home	None	NA	NA	NA

LOS = length of stay; NA = not available; NK = not known; rehab = rehabilitation; RT = radiation therapy.
* For spine metastases.

TABLE 4. Patient outcomes

Case No.	Cancer Type	Total Surgeries	Time to Last Follow-Up or Death (mos)	Preop KPS Score	Postop KPS Score	Change in KPS Score	Preop ASIA Score	Postop ASIA Score	Change in ASIA Score	Improved Pain	Local Recurrence	Outcome
1	Cervical	1	37	90	90	Stable	E	E	Stable	Yes	No	Alive; NI
2	Cervical	1	26	80	80	Stable	D	E	Improved	Yes	No	Deceased
3	Endometrial	1	28	80	80	Stable	E	E	Stable	Yes	No	Alive
4	Endometrial	1	25	90	90	Stable	E	E	Stable	Yes	No	Deceased
5	Leiomyosarcoma	3	34	80	90	Improved	D	E	Improved	Yes	No	Deceased
6	Leiomyosarcoma	1	6	90	No follow-up	No follow-up	E	No follow-up	No follow-up	No follow-up	No follow-up	Deceased

were alive at last follow-up, including the 2 patients who were treated surgically.

For patients with leiomyosarcoma of gynecological origin, a total of 11 articles describing 18 cases of spine metastasis were found (Table 7). Median age at presentation was 49 years (range 35–64 years). The most common location involved was the thoracic spine (10 of 18), followed by the lumbar spine (9 of 18). Thirteen patients were treated surgically. Four patients developed postoperative recurrence in the spine. Of the 14 patients with known survival, the median survival was 22.5 months (range 3.3–120 months). The 1-year and 5-year survival rates were 64% and 21%, respectively. Ten patients were alive at last follow-up.

Patient Survival

Among our cases and the cases found in the literature, 2 cases of cervical cancer, 26 cases of endometrial cancer, and 16 cases of leiomyosarcoma had known survival after diagnosis of spinal metastasis. Of note, for cervical cancer, our case series is the first to report known survival times for spinal metastasis; the prior 13 cases found in the literature did not report survival. Overall median survival for all cases was 15 months (Fig. 1). Based on our cases and the cases found in the literature, median survival of cervical cancer, endometrial cancer, and leiomyosarcoma patients was 32, 10, and 22.5 months, respectively (Fig. 2).

Discussion

In our series, overall survival following spine surgery for such lesions was 27 months, with cervical cancer, endometrial cancer, leiomyosarcoma survival being 32, 26, and 20 months, respectively. Combined with cases from the literature, median survival of cervical cancer ($n = 2$), endometrial cancer ($n = 26$), and leiomyosarcoma ($n = 16$) patients was 32, 10, and 22.5 months, respectively. Although surgery for leiomyosarcoma spine metastases has shown benefit in improving pain and neurological function,^{9,38} similar to other spinal metastases,^{6,13} to the best of our knowledge, the surgical outcomes of patients with cervical or endometrial metastases to the spine has not been reported. Here, we present a case series of patients who underwent resection of a gynecological metastasis spinal lesion and combine our series with all reported cases in the literature.

Surgery for Spinal Metastasis From Cervical Cancer

For cervical cancer, the reported prevalence of spine metastases ranges from 0.6% to 6.5%, with the lumbar spine being the most common site.^{4,10,12,19,23,28,35} Once diagnosed with bone metastases from cervical cancer, treatment is focused on palliation as prognosis is poor, with the majority of patients dying within 1 year.²³ Interestingly, the primary tumor of both of our patients with cervical cancer was diagnosed after presenting with spine metastases. They survived an average of 32 months; however, their survival is difficult to compare with prior studies, which examine length of survival of all patients with bone metastases rather than survival of those with spine metastases alone. In these studies, survival from discovery of

TABLE 5. Characteristics of previously published cases of cervical cancer metastases to the spine

Author	Patient Presentation	Time to Spine Metastasis		Primary Tumor Treatment	Histology	Stage	Location	Other Metastases	Imaging Findings	Operation	Adjuvant Therapy	Time to Last Follow-Up	Outcome
Bassan & Glaser, 1982	53-yo F	NK	NK	RT & hyst	PD SCC	1B	Lumbar	Yes	NK	NK	NK	NK	Deceased
	48-yo F	NK	NK	RT & hyst	PD SCC	1A	Lumbar	No	NK	NK	NK	NK	Deceased
	53-yo F	NK	NK	RT	PD SCC	1A	Lumbar	Yes	NK	NK	NK	NK	Alive at last follow-up
	45-yo F	NK	NK	RT	PD SCC	III	Dorsal	No	NK	NK	NK	NK	Deceased
	30-yo F	NK	NK	RT & hyst	PD SCC	IB	Lumbar	Yes	NK	NK	NK	NK	Deceased
	84-yo F	NK	NK	RT	PD SCC	IIB	Dorso-lumbar	No	NK	NK	NK	NK	Alive at last follow-up
63-yo F	NK	NK	NK	RT	PD SCC	IIA	Lumbar	Yes	NK	NK	NK	NK	Alive at last follow-up
45-yo F	NK	NK	NK	Chemoradiation	PD SCC	IIA	Lumbar	Yes	NK	NK	NK	NK	Alive at last follow-up
72-yo F	NK	NK	NK	RT	PD SCC	IIB	Dorsal	No	NK	NK	NK	NK	Alive at last follow-up
78-yo F	NK	NK	NK	RT	PD SCC	IIB	Lumbar	No	NK	NK	NK	NK	Deceased
70-yo F	NK	NK	NK	RT	Well differentiated SCC	IIB	Lumbar	No	NK	NK	NK	NK	Deceased
George & Lai, 1995	60-yo F w/ a flank mass & weight loss	NK	NK	NK	NK	NK	L1-3	No	Radiography: sclerotic L-1 VB, osteopenic L-2, & L-3 VBs	NK	NK	NK	NK
Ferroir et al., 2001	37-yo F w/ neck pain, paresthesias of the face & neck, & difficulty w/ phonation & swallowing	0 yr	0 yr	Brachytherapy w/ colpohysterectomy	Invasive epidermoid carcinoma	NK	Occipito-vertebral junction	Yes	CT: osteolysis of clivus, mass at C-1	None	RT & systemic chemo: 6 courses of cisplatin & 5-FU	Few mos	Deceased

Chemo = chemotherapy; PD = poorly differentiated; SCC = squamous cell carcinoma; 5-FU = 5-fluorouracil.

TABLE 6. Characteristics of previously published cases of endometrial cancer metastases to the spine

Author	Patient Presentation	Time to Spine Metastasis (mos)		Primary Tumor Treatment	Histology	Stage/Grade	Location	Other Metastases	Imaging Findings	Operation	Adjuvant Therapy	Time to Last Follow-Up (mos)	Outcome
Albareta et al., 2008	62-yo F w/ sacral met found on imaging	36		TAH/BSO	AC	IB/G1	Sacrum	No	MRI: 3.5 mass	Sacroctomy through posterior approach from S-2 w/ en bloc excision of met	Palliative treatment w/ external radiotherapy (30 Gy) & external beam (37 Gy); medroxyprogesterone at 140 mg/day.	26	Disease free & asymptomatic
Arnold et al., 2003	63-yo F w/ 6-mo history of LBP, & 3-wk history of leg weakness	0		TAH/BSO	AC	IVB/G1	T-12	No	Radiography: T-12 & 12th rib	T12 Vertebroctomy & anterior spinal fusion	Postop RT to thoracolumbar spine for 2 mos; medroxyprogesterone 500 mg/day	60	Disease free & asymptomatic
Karamaz et al., 2002	67-yo F w/ complete paraplegia after spinal epidural anesthesia	0		NK	NK	NK	T-6	No	MRI: tumor at T-6 compressing cord	None	RT & chemo	NK	NK
Kehoe et al., 2010	61-yo F	44		TAH/BSO, WPRT	AC	IIIA/G1	Vertebrae	NK	NK	NK	RT	12	Deceased
	65-yo F	3		WPRT, interstitial RT	AC	IIIB/G3	Vertebrae	Yes	NK	None	Chemo	9	Deceased
	58-yo F	10		TAH/BSO	AC	IA/G3	L4-5	NK	NK	NK	RT & chemo	199	Alive w/ disease
	47-yo F	0		TAH/BSO, chemo	AC	IVB/G2	Vertebrae	Yes	NK	None	RT & chemo	27	Deceased
	55-yo F	25		TAH/BSO	AC	Unstaged/G2	Vertebrae	Yes	NK	None	Chemo	7	Deceased
	71-yo F	16		SCH/BSO, chemo	AC	IVB/G2	L1, L3-4	NK	NK	None	None	1	Deceased
	74-yo F	8		TAH/BSO, WPRT	AC	IB/G3	Vertebrae	Yes	NK	None	RT & chemo	5	Deceased
	62-yo F	1		TAH/BSO, WPRT, IVRT	AC	IVB/G3	Vertebrae	NK	NK	None	RT & chemo	16	Deceased

(continued)

TABLE 6. Characteristics of previously published cases of endometrial cancer metastases to the spine (*continued*)

Author	Patient Presentation	Time to Spine Metastasis (mos)	Primary Tumor Treatment	Histology	Stage/Grade	Location	Other Metastases	Imaging Findings	Operation	Adjuvant Therapy	Time to Last Follow-Up (mos)	Outcome
Kehoe et al., 2010 (<i>continued</i>)												
	62-yo F	11	TAH/BSO, WPRT, IVRT	AC	IIIC/G2	Vertebrae	Yes	NK	NK	None	54	Deceased
	52-yo F	148	TAH/BSO, WPRT	NK	Unstaged/ NK	Vertebrae	NK	NK	NK	None	7	Deceased
	77-yo F	0	TAH/BSO, WPRT	AC	IVB/G3	Sacrum	Yes	NK	None	RT & chemo	8	Deceased
Loizzi et al., 2006	51-yo F w/ 3-mo history of cervical pain	0	TAH/BSO	AC	IVB/G3	C5-7	No	CT: metastatic lesions to C5-7 & C-3 fracture	None	Chemo: 1 cycle of cisplatin, doxorubicin, & zoledronic acid	2	Deceased
Uccella et al., 2013	65-yo F w/ weakness, decreased sensation	8	NK	AC	Unstaged/ G2	T-5	No	NK	NK	RT & HT	9	Deceased
	66-yo F w/ pain, inflammation	18	NK	Serous	IIIC/G3	T-12	Yes	NK	None	Bisphosphonates	6	Deceased
	71-yo F w/ pain	3	NK	AC	IC/G3	Sacrum	Yes	NK	None	RT	6	Deceased
	69-yo F w/ pain	49	NK	AC	IB/G3	Sacrum	Yes	NK	None	HT	31	Deceased
	62-yo F w/ pain	14	NK	AC	IIIC/G3	T-4, T-11, sacrum	Yes	NK	None	RT	6	Deceased
	62-yo F w/ pain, limp	20	NK	AC	IB/G2	Sacrum	No	NK	None	RT & HT	11	Deceased
	70-yo F w/ pain	20	NK	AC	IB/G2	T-9, L-3	Yes	NK	None	RT	5	Deceased
	59-yo F w/ pain	13	NK	AC	IC/G1	T-10	No	NK	None	RT	119	No evidence of disease
	80-yo F w/ pain	0	NK	AC	IVB/G3	Sacrum	Yes	NK	None	HT	2	Deceased
	60-yo F w/ pain	34	NK	Serous	IB/G3	L-3	No	NK	None	RT	14	Deceased

AC = adenocarcinoma; HT = hormone therapy; IVRT = intravaginal radiotherapy; SCH = supracervical hysterectomy; TAH = total abdominal hysterectomy; WPRT = whole pelvic radiation therapy.

TABLE 7. Characteristics of previously published cases of leiomyosarcoma metastasis to the spine

Author	Patient Presentation	Time to Spine Metastasis (yrs)		Primary Tumor Treatment	Physical Exam	Location	Other Metastases	Imaging Findings	Operation	Adjuvant Therapy	Time to Last Follow-Up (mos)		Outcome
Arnesen & Jones, 1992	56-yo F w/ LE pain & tetraplegia	5		Hyst	NK	T11–12	None	MRI: destructive lesion involving the posterior elements	Decompressive surgery	RT	6		Alive at last follow-up
Elhammady et al., 2007	45-yo F w/ history of lumbar pain, found to have spine mets on imaging	0		None	Normal	L-2	None	MRI: low signal on T1-weighted images, heterogeneous signal on T2-weighted signal, & enhancement	L-2 corpectomy, gross total resection, reconstruction & fusion	Chemo & RT: Adriamycin & cisplatin, cyberknife	42		Alive at last follow-up
	46-yo F w/ LBP, LE numbness	14		Hyst	NK	T-11, L-2	None	CT/MRI: lytic lesion involving vertebrae; PET: hypometabolic	Bilat transpedicular decompression & instrumentation at T-11 & L-2	None	36		Alive at last follow up
	36-yo F w/ LBP, rt LE pain	6		Hyst	NK	L-5	None	CT/MRI: multiple blastic lesions & a lytic lesion involving L-5 vertebrae w/ retroperitoneal & epidural components	Decompressive laminectomy & instrumented fusion	Chemo: adriamycin	108		Deceased
	42-yo F w/ LBP, lt LE pain	12		Hyst	NK	L-3	None	MRI: hypointense lesion on T-1, heterointense on T-2, lesion involving the vertebrae	Decompressive laminectomy & instrumented fusion	None	96		Alive at last follow-up
Gardner, 1917	55-yo F w/ pain, tetraplegia	1		Hyst	NK	T-1, T-3	Ribs	NK	NK	None	48		Deceased

(continued)

TABLE 7. Characteristics of previously published cases of leiomyosarcoma metastasis to the spine (*continued*)

Author	Patient Presentation	Time to Spine Metastasis (yrs)		Primary Tumor Treatment	Physical Exam	Location	Other Metastases	Imaging Findings	Operation	Adjuvant Therapy	Time to Last Follow-Up (mos)	Outcome
Nanassis et al., 1999	46-yo F w/ 2 wks of neck pain, rapidly progressive paraplegia	3		Hyst	Incomplete spastic paraplegia, complete loss of sensory function distal of T5–6 dermatomes	T2–3	None	MRI: extramedullary lesion in extradural space at T2–3 dorsal to cord	Decompressive surgery & tumor resection	None	22	13 mos after surgery: free of clinical symptoms. She developed wide-spread mets 9 mos after this w/ lesions in skull, L-2, sacral bone, & it ischiadic bone.
Robbins, 1943	56-yo F w/ back pain radiating to the legs	1		Hyst	NK	L-2	None	Blastic lesion, myelographic block at L-2	NK	RT	12	Deceased
Schjott-Rivers, 1949	51-yo F w/ LBP	3		Hyst	NK	L-4	NK	Blastic lesion	NK	RT	120	Deceased
	51-yo F w/ LBP	3		Hyst	NK	L-5	NK	Compression fracture	NK	RT	NK	NK
Shapiro, 1992	64-yo F w/ progressive tetraparesis	15		Hyst	NK	T-5	None	Myelographic block at T-5, mass arising from lamina	Decompressive surgery	RT	12	Alive at last follow-up
Takemori et al., 1993	47-yo F w/ back pain for 2 mos	2		Hyst	NK	T-8	None	MRI: solitary met in T-8	T-8 corpectomy w/ ceramic prosthesis & anterior spinal stabilization	Chemo: 4 courses of cyclophosphamide, vincristine, adriamycin, dacarbazine	NK	Alive at last follow-up w/ no evidence of recurrence
Tan et al., 2013	44-yo F w/ 1-mo history of it LE monoplegia, decreased sensation below T-4 dermatome, urinary incontinence	3		Hyst	Quadripareisis, decreased sensation below T-4 dermatome	C6–T2	None	MRI: diffusely enhancing intramedullary lesion from C-6 to T-2	C5–T2 reconstructive laminoplasty w/ tumor resection	RT & chemo: EBRT w/ 5000 cGy in 25 fractions; doxorubicin & ifosfamide	NK	NK

(continued)

TABLE 7. Characteristics of previously published cases of leiomyosarcoma metastasis to the spine (*continued*)

Author	Patient Presentation	Time to Spine Metastasis (yrs)	Primary Tumor Treatment	Physical Exam	Location	Other Metastases	Imaging Findings	Operation	Adjuvant Therapy	Time to Last Follow-Up (mos)	
										Wks	Deceased
Willis, 1973	47-yo F w/ back pain immediately following treatment for primary cancer (leiomyosarcoma)	0	Hyst	NK	Lumbar spine	None	Lytic lesion	NK	None		
Ziewacz et al., 2012	35-yo F w/ radiating pain in arm & back	NK	NK	NK	T1–3	NK	NK	T-2 hemilaminectomy w/ tumor resection, C6–T4 posterior fusion	Chemo & RT	11.5	Tumor recurred at 7 mos w/ repeat surgery at 9 mos postop
	57-yo F w/ back pain, sensory changes, loss of function in hand, autonomic dysfunction, inability to ambulate	NK	NK	NK	T-1	NK	NK	C7–T2 laminectomy, T-1 corpectomy, C5–T3 posterior fusion	Chemo & RT	20.3	Tumor recurred at 9 mos postop requiring repeat surgery
	57-yo F w/ rt foot tingling, radicular pain in buttocks & thigh	NK	NK	NK	L4–S1	NK	NK	L4–S1 hemilaminectomy	Chemo & RT	23	Tumor recurred at 13.8 mos requiring repeat surgery
	51-yo F w/ bilateral LE weakness, tingling, & numbness	NK	NK	NK	T2–4	NK	NK	T2–4 laminectomy, T1–5 posterior fusion	None	3.3	Deceased

EBRT = external beam radiotherapy; LBP = low-back pain.

FIG. 1. Graph showing overall survival of all patients with gynecological metastases to the spine.

bony metastases ranges from 2 to 7 months.^{10,23,28,35} From case reports (Table 5), 6 (46%) of 13 reported patients were alive at last follow-up, but survival rates at specific time points could not be calculated as length of survival was not reported in these cases.

Surgery for Spinal Metastasis From Endometrial Cancer

The majority of endometrial spine metastases are presented as case reports or case series (Table 6).^{1,3,17,18,21,36} Based on these studies, there appears to be no predilection of location within the spine, and treatment is typically non-surgical. Prognosis is similarly poor, with the majority of patients dying from their disease, with a median survival in the literature of 6–9 months after diagnosis of spine metastasis.^{18,36} From the reported literature cases alone (Fig. 2), 1-year and 5-year survival rates were 38% and 8.3%, respectively, with an overall median survival of 9 months. Our patients with endometrial spine lesions survived for a median of 26 months after discovery of their spine metastasis. Of note, our series showed a substantially larger blood loss with such lesions compared with the cases of cervical cancer and leiomyosarcoma. Such a finding can likely be explained by the high vascularity of the primary organ itself, namely the endometrium, and thus concern for increased blood loss should be expected when operating on such lesions.

Surgery for Spinal Metastasis From Leiomyosarcoma

Leiomyosarcoma metastases to the spine have been well-described, affecting younger patients and having a predilection for the thoracic or lumbar spine.^{9,38} Our patients had a mean age of 44 years, which is younger than the mean age of 50.9 and 53.8 years as described by Elhammady et al. and Ziewacz et al., respectively.^{9,38} Previously reported survival ranges from weeks to 13 years⁹ (Table 7) and generally seems to be longer than that for other gynecological malignancies. One-year and 5-year survival of patients from case reports (Fig. 2) is 64% and 21%, respectively, with an overall median survival of 22.5 months. In our series, patients with leiomyosarcoma had

FIG. 2. Graph showing survival of patients with gynecological metastases to the spine by cancer type. For cervical cancer, survival is based on the 2 patients in our case series; the 13 cases found in the literature did not report survival and were excluded. For endometrial cancer, survival was calculated from our 2 cases as well as 24 cases from the literature with known survival; 1 case from the literature was excluded. For leiomyosarcoma, survival was calculated from our 2 cases and 14 cases from the literature; 4 cases from the literature were excluded. Figure is available in color online only.

the shortest survival, dying 20 months after spine metastasis diagnosis. This may be due to the fact that our patients had widespread metastases at the time of diagnosis. As has been previously shown,^{9,38} surgery with intralesional resection and stabilization improved pain and neurological function in our patients.

Surgical Outcomes for All Gynecological Cancers

In all of our patients with spine metastasis secondary to gynecological cancer, surgery was safe and without post-operative complications. All of our patients with known follow-up had stable or improved neurological outcomes, performance status, and improved pain, without local recurrence of tumor. Due to the limited number of cases in our study, the variation in survival as compared with the literature may be due to several factors such as differences in the grading, stage, and treatment of the primary tumor; involvement of the spine metastases; and baseline health of the patients at presentation. Another limitation of our study is that due to its retrospective nature, formal quality of life measures via instruments like the SF-36 or QoL5 could not be obtained and evaluated.

Spinal metastases of gynecological cancer are relatively rare, and because of this, prior reports are generally described within the context of all bony metastases, regardless of location. Additionally, few reports exist on the surgical outcomes for these patients, and thus the survival, complications, and patient satisfaction following surgery for spinal metastases from such malignancies are not clearly defined. Although our experience shows that surgery can be effective in improving pain and neurological function in a small number of patients with gynecological metastases to the spine, further prospective studies that include formal quality of life measures are needed to understand the outcomes following surgery for patients affected by these rare lesions.

Conclusions

Gynecological cancers rarely metastasize to the spine. Combining such information with other preoperative factors may more accurately aid in surgeon management of these rare spinal lesions. When combined with previously reported cases in the literature, overall survival of all patients following diagnosis of gynecological metastasis to the spine was 15 months. Survival differs depending on primary histology, with decreasing survival from cervical cancer (32 months) to leiomyosarcoma (22.5 months) to endometrial cancer (10 months).

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