Chapter 15
Cervical Spinal Oncology

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Abbreviations

AJCC	American Joint Commission on Cancer
ASA	American Society of Anesthesiologists
CCI	Charlson Comorbidity Index
ESCC	Epidural spinal cord compression
mFI-5	Modified Frailty Index—5-item
MIS	Minimally invasive surgery
MSTS	Musculoskeletal Tumor Society
R0	Resection with no evidence of tumor cells on microscopic examination
RFA	Radiofrequency ablation
SEER	Surveillance, Epidemiology, and End Results
SINS	Spinal Instability Neoplastic Score
SLITT	Spinal laser interstitial thermotherapy
WBB	Weinstein-Boriani-Biagini

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Introduction

Spinal oncology can be divided into four groups based upon two diagnostic axes—(1) whether the tumor is primary or metastatic and (2) whether the tumor arises from the vertebral column or from the spinal cord and meninges. Of these, metastases of the vertebral column are by far the most common lesion type, followed by primary lesions of the spinal cord and meninges [1]. Primary lesions of the vertebral column are far more uncommon – estimated to occur in 2–3 patients per million population per year [1, 2]. Metastases isolated to the spinal cord and meninges are exceedingly uncommon [3].

Among the elderly, which we operatively define here as those greater than 60 years of age, the most common lesion types are spinal column metastases (71–105 cases per 100,000 population per year), [4] primary tumors of the spinal cord and meninges (2–2.7 per 100,000 per year and 0.9–1.4 per 100,000 per year, respectively), [1] and primary vertebral column tumors (≈5 per million per year) [1]. The optimal management strategies of these lesion types will be the focus of this chapter.

Frailty in the Elderly Spine Oncology Patient

Frailty is a somewhat vague concept used to describe the increased vulnerability that comes with aging-associated decline in physical reserve and function [5]. Clinical surrogates that have been used for frailty include weight loss or cachexia, [6] muscle loss or sarcopenia, [7–9] physical endurance, hypoalbuminemia/malnutrition, [10] and nutritional risk [11]. Multiple frailty assessment instruments have also been developed, [12] of which the most common are the physical frailty phenotype, [13] the deficit accumulation index, [14] and the vulnerable elders survey [15]. Within the spine literature, the Modified Frailty Index-5 (mFI-5) [16–18] and the American Society of Anesthesiologists (ASA) classification have also been employed as frailty metrics [19].

Previous investigations into the impact of frailty on spine oncology outcomes has yielded mixed outcomes. Zakaria investigated the impact of sarcopenia—low skeletal muscle mass—in patients with spinal metastasis and found it to be an independent predictor of increased overall mortality for both surgical and radiosurgical patients [7, 8]. Similarly, Charest-Morin, using the mFI-5, found greater frailty to be an independent predictor of prolonged hospitalization in patients undergoing en bloc resection of a primary or metastatic vertebral column tumor [18]. By contrast, Bourassa-Moreau et al. [20] found that frailty, as measured by previously validated indices (e.g. the mFI-5), did not predict either mortality or complication in patients undergoing emergent surgery for spinal metastasis. Nevertheless, they did find that sarcopenia predicting poorer outcomes, suggesting that, in general, frailty, as defined by poorer physical reserve, portends poorer outcomes in spine tumor patients. Fig. 15.1 conceptually represents how age and physical degeneration may factor into the relative risk-benefit profile of spine tumor surgery.

An independent but related concern is the presence of medical comorbidities. In general, patient medical histories increase in complexity with age; diabetes mellitus, [21] hypertension, [22] chronic pulmonary disease, [23] and cancer [24] are all increasingly common in the aged population. These medical comorbidities have been previously analyzed using a number of metrics, of which those most commonly applied to the spinal surgery literature are the Charlson Comorbidity Index (CCI) and ASA class. Greater medical complexity as measured by a higher CCI score or ASA class has previously been tied to prolonged hospitalizations and higher 30-day mortality in patients operated for spinal tumors [25]. Using the National Surgical Quality Improvement Program (NSQIP) database, Lakomkin et al. [25] found that CCI was an even stronger predictor of poor outcomes than ASA class or patient frailty, as assessed by the mFI-5.

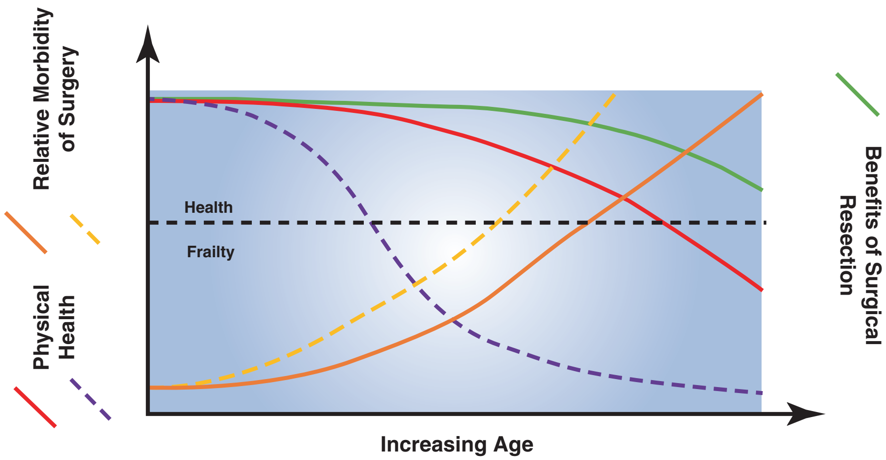

Fig. 15.1 Schematic representation of the relative costs and benefits of surgical intervention for spine tumors superimposed on a plot of physical health as a function of age. As the plot demonstrates, physical health worsens with increasing age. Under normal aging (red line), this process occurs gradually, whereas under certain conditions, patients experience a process of advanced aging (purple line). Those experiencing advanced aging cross the boundary between health and frailty at an earlier age than those aging at a normal rate. The incremental benefits of surgery (green)—commonly thought of in terms of overall or disease-specific survival—tend to decrease with age for most tumor pathologies, reaching a minimum at the point where the expected disease-specific survival equals or exceeds the actuarial survival for someone of the patient's age and general condition *without* active malignancy. Relative procedural morbidity also increases with age (orange line) as the pulmonary function and wound healing abilities of the patient decrease. Under the conditions of advanced aging (gold line), the relative morbidity may rise at an accelerated rate. Consequently, patients demonstrating advanced frailty may experience a relative reversal of the expected risks and benefits of surgery at an earlier age, as reflected by the intersection of the gold line with the green "benefit" line at a younger age relative to the orange line

Primary Spine Tumors

As stated above, primary spine tumors can be divided into those arising from the bones and those arising from the spinal cord, nerve roots, or meninges. The latter are far more common and surgery for these lesions is generally less morbid.

Tumors of the Vertebral Column

For the purposes of this discussion, we define primary tumors of the vertebral column as all malignancies arising from the bone of the mobile spine and sacrum. There are many benign lesions (e.g., chondroblastoma, enchondroma, giant cell tumor, osteoblastoma) that arise from the spinal column; however, these oftentimes do not require surgical management. Primary malignancies of the mobile spine and sacrum are exceedingly rare, occurring in only 2–3 patients per million population annually. Nevertheless, they are predominately seen in patients over the age of 50, with peak incidence in the sixth and seventh decade of life [1]. Disease burden is slightly higher among females (≈5:4); however, rates do not differ substantially.

The most common primary vertebral column malignancies are osteosarcoma (osteogenic sarcoma), chordoma, chondrosarcoma, and Ewing sarcoma. The optimal management of each lesion type is beyond the scope of this chapter; however, they can largely be split into two groups. The first group, comprised of osteosarcoma and Ewing sarcoma, benefits from neoadjuvant chemotherapy administration [26, 27]. For osteosarcoma, common regimens include methotrexate, doxorubicin, ifosfamide, cisplatin, or a three-agent regimen of bleomycin, cyclophosphamide, and dactinomycin. For Ewing sarcoma, a typical regimen is 12 cycles of vincristine, ifosfamide, and alternating actinomycin D and doxorubicin [26]. Chordoma and chondrosarcoma comprise the second group—those lesions for which chemotherapy has little to no efficacy.

Examination of population-level data, such as the Surveillance, Epidemiology, and End Results (SEER) database, suggest that all four lesion types benefit from surgical resection [28]. Specifically, en bloc resection with negative margins (R0 resection) has been demonstrated [29, 30] to offer superior survival in chordoma, [31–33] chondrosarcoma, [34–38] osteosarcoma, [39, 40] and Ewing sarcoma [41, 42]. Despite the apparent benefits in terms of local control and overall survival, surgery for primary osseous spinal malignancies is among the most morbid of neurosurgical procedures. Many elderly patients may be too ill to reasonably pursue surgical intervention and should instead be treated with a combination of radiotherapy for local control and pain relief, cementoplasty for spinal column stabilization, and chemotherapy for control of metastatic spread.

Patients, especially those who are advanced in age, benefit from multidisciplinary management and thorough evaluation of their preoperative health status. Those deemed healthy enough for surgery then undergo a process of oncologic staging (e.g., with positron emission tomography and/or computed tomography of the chest, abdomen, and pelvis) and surgical staging. The Enneking or Musculoskeletal Tumor Society (MSTS) system [43, 44] has been the staging system of choice for nearly 30 years. But recently, the American Joint Commission on Cancer (AJCC) published a TNM system for primary spine malignancies that incorporates elements of tumor morphology in addition to locoregional spread [45]. Many spinal oncologists still use the former system; however, it seems likely that in the near future the AJCC system may become standard due to shared features with the other TNM systems, which are widely employed in medical oncology [46].

Lesions that demonstrate no evidence of spread beyond local nodes may be reasonably approached for en bloc R0 resection. The Weinstein-Boriani-Biagini (WBB) [47] is a surgical staging system well-known to spinal oncologists that divides each spinal segment into concentric tissue layers, each comprised of 12 sectors arranged like a clockface (Fig. 15.2). The sectors involved dictate whether an anterior or posterior approach is preferrable. For lesions of the subaxial spine, an anterior approach is generally preferred for tumor delivery; a second posterior approach for stabilization may also be required. For lesions of the craniocervical junction, more invasive approaches are often necessary, including a staged posterior-anterior approach with a transmandibular anterior stage for lesions of the craniocervical junction or a transmanubrial approach for lesions of the cervicothoracic junction. Previous investigations have suggested that it may be used to accurately predict which lesions can be resected en bloc with wide or marginal margins in 88% of cases [48]. However, it must be noted that the vertebral arteries and nerve roots feeding the brachial plexus potentially complicate the resection of these lesions [49, 50]. In general, we favor preservation of the roots feeding the brachial plexus, given their vital role in daily function. Preservation of these nerves may lead to intralesional or marginal resection though. By contrast, we favor sacrifice of the vertebral artery to achieve en bloc R0 resection, if there is sufficient perfusion of the posterior circulation by the contralateral vertebral artery [51].

Though most primary sarcomas are conventionally thought of as radiation-resistant, modern radiation modalities, including focused photon therapy, proton therapy and hadron therapy (e.g. carbon ion therapy) have been shown to be effective [52]. Consequently, radiotherapy has become a key part of the treatment paradigm for most patients with primary bone tumors [2, 53–58]. Proton and hadron therapies may have advantages in terms of reduced radiation to adjacent healthy tissues. Lastly, some preliminary experiences have suggested that definitive, high-dose proton or hadron therapy may be useful for local control in those patients unable or unwilling to tolerate the morbidity of surgical management [59–61].

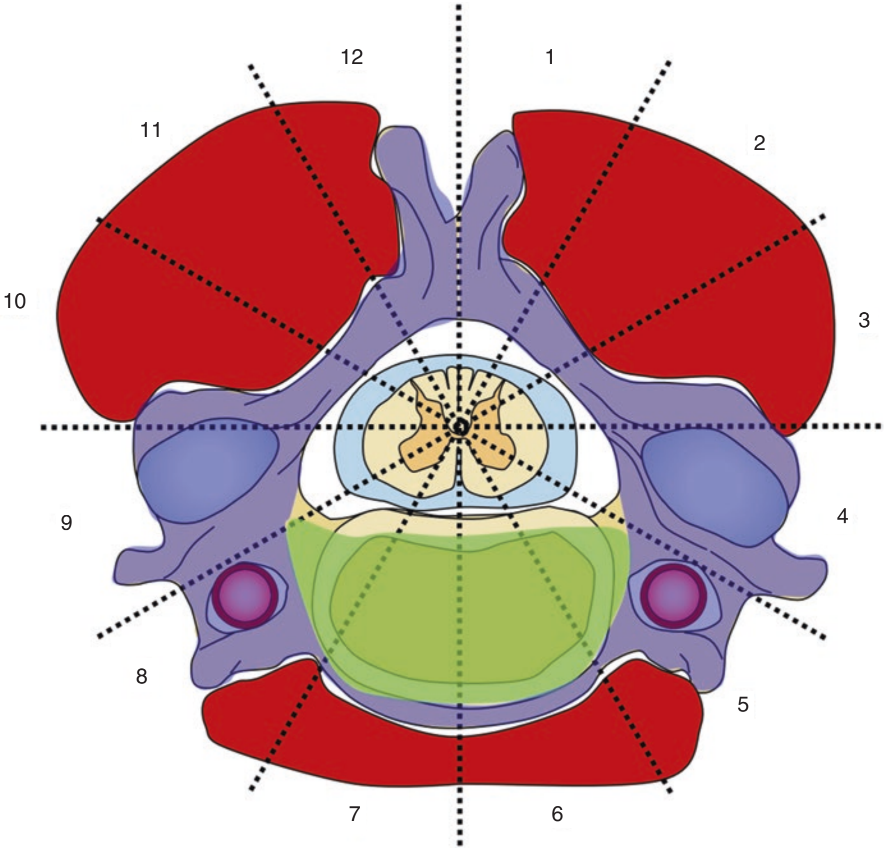

Fig. 15.2 Weinstein-Boriani-Biagini (WBB) system applied to the cervical spine. Concentric tissue layers are (A) the extraosseous soft tissues/muscle, (B) the superficial bone (intraosseous compartment—blue), (C) the deep bone (intraosseous compartment—green), (D) the epidural compartment, and (E) the intradural compartment

Tumors of the Spinal Cord and Meninges

Primary lesions of the spinal cord and meninges show peak incidence in the seventh decade of life; more than 40% of meningeal lesions and nearly 30% of spinal cord lesions are documented in patients over the age of 60 [1]. Like primary vertebral column tumors, lesions are more common among women (M:F ≈ 3:2 for meningeal lesions and 6:5 for spinal cord lesions) [1]. For both intramedullary and extramedullary lesions, cervical localization is less common than thoracic localization but accounts for a nontrivial proportion of cases [62].

Intradural Extramedullary Lesions

The most common histologies for intradural extramedullary tumors are schwannomas and meningiomas [63–66]. Surgical resection has conventionally been the treatment of choice for both pathologies [67, 68]. It is indicated for patients with neurological deficits secondary to neural element compression (e.g., spinal cord compression in meningiomas). Increased age is a known risk factor for postoperative venous thromboembolism, 30-day mortality, 30-day reoperation, 30-day unplanned readmission, and nonroutine discharge [69–71].

Meningiomas are uncommon in the cervical spine relative to the thoracic region, but 14–27% localize to the cervical spine [64]. Dorsal lesions can usually be addressed in patients that are considered poor substrates, such as elderly patients with extensive medical comorbidities, and definitive radiotherapy may be a reasonable alternative for spinal. A recent review of the SEER database demonstrated that this is only employed in ≈1% of patients though [72]. Such population-level data lacks the granularity to explain the reason for this treatment method. However, it can be speculated that patients generally receive surgery, as it is the best means of relieving preoperative neurological deficits. Gross total resection is possible in 82–99% of cases, though it may be difficult or impossible in calcified lesions [64]. The exact approach entertained is dependent upon the location of the lesion; dorsal lesions can be effectively treated with laminoplasty and Simpson grade I/II resection. However, anterior or anterolateral localization appears more common in cervical tumors [71, 73]. A dorsal or dorsolateral approach with sectioning of the dentate ligaments is generally effective for these lesions. However, for ventral lesions abutting the cervicothoracic cord, a transcervical approach with anterior cervical corpectomy and fusion may be entertained [73, 74]. In must be noted that such anterior approaches carry increased risk of dysphagia with age, especially among patients >60 years old [75, 76]. Complication rates are relatively low (0–3%) as is local recurrence (1–6%) [64]. Local control appears comparable for Simpson grade I and grade II resection, [77] though debate remains about this issue [78, 79].

Schwannomas, by contrast, are generally easily addressed from a posterior-only approach, and several large series have been published describing their management, including those of Conti et al., [80] Lenzi et al., [81] Seppälä et al., [82] and Safaee et al. [83, 84] Reported rates of gross total resection vary widely, ranging from 21% to 99% of cases; [80, 84] rates of gross total resection may be lower for cervical lesions [84]. All report relatively good outcomes, with neurological recovery seen in 56–73% of patients [80, 81] and significant improvements in functional status [80]. Based upon the result of Lenzi et al., [81] sensory deficits are both more common than motor deficits preoperatively and more likely to recover after surgical resection. However, many patients (up to 80%) are left with residual preoperative neurological deficit or a new postoperative neurological deficit [82]. It is essential that patients be warned of these likely complications prior to surgery. For patient unwilling to tolerate these deficits or who are unable to otherwise tolerate surgery, radiosurgery may also be an effective option for pain control and symptom stabilization [67, 68, 85–87].

Intradural Intramedullary (Intrinsic) Lesions

Increased age is similarly a predictor of worse outcomes amongst patients being treated for intrinsic/intramedullary spinal cord tumors. [88] The most common intrinsic lesions include ependymoma, astrocytoma, and hemangioblastoma [62, 65, 66, 89]. Unlike extramedullary lesions, surgery is generally the only option for the management of intrinsic lesions. In the case of ependymoma and hemangioblastoma, curative resection is often possible and improves progression-free survival [90–93]. Therefore, patients who are healthy enough to undergo surgical management should be treated with definitive resection, irrespective of age. By contrast, astrocytomas generally have ill-defined margins [92, 94]. Therefore, the patient and surgeon must have a more extensive discussion about the relative balance between the benefits spinal cord decompression and the new neurological deficits that are unavoidable with such surgeries. Cervical lesions are thought to have the highest rates of postoperative neurological worsening [92] and lowest likelihood of achieving optimal neurological outcomes [93]. Ill-defined tumor planes, [90] larger tumor size, [95] and increased age [93] are also associated with poorer neurological outcomes. Lastly, some prior series suggest that sensory symptoms are the most likely to improve following surgery [96]. Patients looking for improvements in motor or bowel/bladder function may therefore expect relatively less benefit than patients looking for sensory improvements. This warrants further investigation though.

Metastatic Lesions

The age profile of patients with metastatic spine tumors largely reflects the profile of all patients with oncologic disease, which is perhaps unsurprising, given that 40–70% of patients with newly diagnosed cancer will develop spine metastases [97]. However, only a small subset of patients with metastatic spine disease will have indications for surgical intervention [98]. The most common primary malignancies vary somewhat based upon the population under examination, but, in general, the most common primaries—lung, prostate, and breast—are the same as the most common primary malignancies in the general population [99]. Hepatocellular carcinoma and gastric adenocarcinoma are also common among East Asian populations, [4] consistent with the higher incidence of these cancers in Eastern Asia. Although cervical metastases are the least common, they are the easiest to address surgically.

Goals of Surgery

The primary goals of surgery for metastatic spine disease are to address underlying mechanical instability and to relieve compression on the neural elements. Assessment of mechanical instability relies on a combination of radiographic and clinical assessment. Biomechanical studies—finite element analyses and cadaveric experiments—have demonstrated that greater instability is associated with larger lesion size [100–103]. Additionally, finite analyses have suggested that decreases in axial loading capacity may be greatest for more cranially situated vertebrae [100]. Poor underlying bone quality, which is common in the elderly, also lowers vertebral body yield strength, [102] as does involvement of the posterolateral elements [104, 105].

The aggregate of these findings in turn led to the development of the Spinal Instability Neoplastic Score (SINS), a decision-making aid developed by the Spinal Oncology Study Group [106] that has been demonstrated to have high inter- and intra-rater reliability [107]. SINS scores lesions on a scale from 1 to 18 based upon underlying bone quality, extent of vertebral body involvement, the presence or absence of pain, posterolateral element involvement, location, and the presence of concurrent deformity. Lesions scoring >12 are deemed mechanically unstable enough to warrant surgical intervention, whereas those scoring ≤6 are deemed nonsurgical. Intermediate scores (7–12) are classified as "potentially unstable"; however, more recent studies have suggested that scores of 10 or above generally benefit from surgical management [108, 109]. Additionally, a recent study by the Memorial Sloan Kettering group [110] suggested that blastic lesions, lesions causing mechanical pain, and lesions of the mobile or junctional spine segments were most likely to experience symptomatic benefit from intervention. Based upon this, it would appear that patient with cervical or cervicothoracic junctional lesions are more likely to experience benefit from surgery than those with lesions of the thoracic spine. Curiously, the results also suggest that patients with blastic lesions experience greater benefit, which is contrary to conventional thought. However, a 2020 finite element analysis suggested that the underlying loading characteristics of blastic lesions are poorer than those of lytic lesions [111]. Further investigations are necessary to evaluate this point.

Neurological deficits are the second major indication for surgical management of spinal metastases, and roughly 20,000 patients each year require intervention for metastatic epidural spinal cord compression (ESCC) [112]. With the publication of the findings of Patchell et al., [112] surgical decompression has been considered the gold standard as it provides superior functional outcomes to radiotherapy alone. Even with the advent of improved, focused radiation modalities (e.g., CyberKnife), surgical decompression remains the intervention of choice for those with tumor directly abutting the cord. Like mechanical instability, ESCC can also be assessed using a validated scoring system—the ESCC scale of Bilsky et al. [113]—that has previously been correlated with the severity of neurological impairment [114]. Lesions with direct tumor-cord contact (ESCC grade 2 and 3) should generally be treated with surgical decompression followed by radiotherapy, so-called separation surgery [115]. However, recent evidence suggests that radiotherapy alone may be reasonable for a select group of ESCC grade 2 patients presenting with either no neurological deficits or mild neurological deficits on presentation [116, 117]. Such decision should be made in consultation with a multidisciplinary care team and knowledge of the patient's treatment goals .However, it may be preferrable for some elderly patients with extensive medical comorbidities that would make them poor surgical candidates.

Who Is a Surgical Candidate?

Ensuring that a patient is a good surgical candidate is paramount for metastatic lesions, as the goal of surgery is symptom palliation, not cure. This is especially true for cervical metastases, which have the highest risk of multiple perioperative complications [118]. Conventionally, surgical candidacy for patients with spinal metastases has been based upon expected postoperative survival, with most spinal oncologists recommending surgery only for those patients with an expected survival of at least 3 months [98]. Pursuant to this, a number of survival predictors have been created, of which the best known are the Tomita [119] and Tokuhashi scales [120, 121]. Early scales were quite simplistic; however, more complex scores have been developed recently using multivariable analyses and machine learning. These newer scoring systems have proven more accurate and include the scoring systems of the Skeletal Oncology Research Group [122–124] and the New England Spinal Metastasis Score [125]. However, recently prospective work has suggested that even patients who do not meet these conventional survival guidelines may benefit from surgical intervention. Dea and the AOSpine Knowledge Forum Tumor [126] recently demonstrated that even patients with postoperative survival times less than 3 months may experience similar, clinically meaningful improvements in health-related quality-of-life outcomes. As a result, expected survival may not be an effective strategy for determining surgical candidacy. Rather, we favor an evaluation that balances the morbidity of surgery against the projected patient benefit in terms of neurological status and quality of life. Those with extensive comorbidities and concordantly high expected morbidity may be harmed more than helped by surgical intervention. By contrast, those with relatively few medical comorbidities may experience a net benefit from surgical treatment, even if they have poor expected survival.

Minimally Invasive Surgical Techniques and Alternatives for Frail Patients

As stated previously, the biggest concern with performing surgery for primary or metastatic lesions of the aged spine is whether the patient is too frail to tolerate the morbidity of surgery. As decreasing a patient's frailty is seldom an option, surgical optimization focuses on reducing procedural morbidity. The most popular means of doing so is through minimally invasive surgery (MIS). MIS techniques are defined by all surgical techniques that minimize soft tissue dissection and the disruption of normal anatomy en route to achieving the goals of surgery. MIS techniques are difficult to employ for primary vertebral body tumors, as en bloc resection with negative margins is the therapeutic gold standard [31, 32] and almost uniformly requires extensive soft tissue dissection. MIS approaches to primary lesions of the spinal cord and meninges, and metastatic vertebral column lesions have been described. For metastatic lesions, separation surgery is the most popular strategy [127, 128]. It makes use of percutaneous instrumentation and a small, posterior midline approach to resect the epidural tumor. The remaining tumor is then irradiated to achieve maximal control. In cases where anterior column reconstruction is required, a mini-open approach has been described, replacing the laminectomy with a transpedicular approach and piecemeal corpectomy [129]. In the cervical spine, however, a posterior approach may not be required, as the lower amount of prevertebral soft tissue means that an anterior cervical corpectomy and fusion via the Smith-Robinson approach is generally adequate [130]. However, for lesions of the craniocervical or cervicothoracic junction, a posterior approach may be necessary to access the tumor or to address underlying instability at these points of increased shear stress.

For primary lesions of the spinal cord and meninges, anterior approaches are generally contraindicated as they would require vertebral column resection to address the primary pathology. Posterior approaches are preferred, and minimally invasive approaches have been described, including endoscope-assisted, percutaneous resection of a cervical foraminal nerve sheath tumors, [131, 132] microscopic hemilaminectomy for resection of an intramedullary spinal cord tumors, [133] endoscope-assisted resection of intradural, intramedullary lesion, [134] and endoscope-assisted resection of intradural, extramedullary lesions [135, 136].

Nonsurgical Alternatives

Although MIS techniques have expanded the proportion of patients who can safely undergo surgical management of their tumors, there remains a nontrivial proportion of patients who are too ill to undergo surgery. For these patients, alternative interventions have been developed. Cementoplasty, which can be divided into vertebroplasty and kyphoplasty, is a percutaneous procedure aimed at stabilizing tumor-affected vertebra. Though uncommonly described in the cervical spine, [137] cementoplasty has been widely used for thoracolumbar lesion. Biomechanical analyses have shown cementoplasty significantly improves the axial loading properties of tumor-affected vertebrae [138]. Clinically, this likely translates to decreased rates of pathologic fracture. Downsides to cementoplasty are that it does not address neural element correction and provides minimal correction of de novo deformity secondary to pathologic fracture. Additionally, both vertebroplasty and kyphoplasty are associated with cement embolus formation and cement extravasation into the epidural space. Risk of cement-related embolic events may be reduced by using higher viscosity cements [139]. Disruption of the posterior vertebral body cortex increases the risk of epidural and venous leakage [140] and has been conventionally held as a contraindication to cementoplasty. However, case series have been published, demonstrating the relative safety of vertebroplasty or kyphoplasty with high viscosity cement in patients with pathologic fractures at high risk for cement leakage [141].

Cementoplasty does not address epidural disease or neural element compression. For this, other technologies have been described. Spinal laser interstitial thermotherapy (SLITT) places an ultraviolet laser probe transpedicularly into the tumor-affected vertebra. The laser heats the tumor up to 78 °C, causing rapid tumor cell death. The procedure is monitored using intraoperative magnetic resonance imaging, to ensure that the epidural space stays within preestablished safe limits [142]. It has been reported as safe even in patients with epidural tumor compressing the spinal cord [142, 143] and may be used as a neoadjuvant to stereotactic radiotherapy for local tumor control. Radiofrequency ablation (RFA) and cryoablation serve similar roles. Like SLITT, RFA uses a low-power (≤20 W per electrode) radiofrequency probe inserted transpedicularly under computed tomography or fluoroscopy guidance to induce coagulative necrosis of the tumor cells [144]. The epidural tumor can then collapse into the necrosed vertebral body lesion, decompressing the spinal cord. It has been shown to have high rates of pain relief and local control in small series [144–146]. Experience with cryoablation is far more limited in spine metastases [147]. It uses a transpedicularly inserted cryoablation probe to instill compressed argon gas into the lesion. The gas chills the tumor cells to ≤−130 °C, inducing coagulative necrosis. This results in indirect spinal cord decompression through a mechanism similar to that of SLITT and RFA. Though most published experiences describe a short post-procedural hospitalization (1–2 days), it may be amenable to outpatient implementation. All three techniques have low associated risk of wound complications, but careful temperature monitoring of the epidural space is necessary to prevent spinal cord injury [148].

Conclusion

Spinal oncology encompasses a breadth of pathologies with very different surgical interventions. Like degenerative disease, tumors are generally more common with age; lesion incidence peaks in the sixth or seventh decade of life for most lesion types. Cervical location is uncommon for most lesion types; however, metastatic and primary tumors of the cervical vertebral column, spinal cord, and meninges are seen at appreciable rates. In all cases, surgery is relatively morbid and care must be taken to ensure that the patient is healthy enough to tolerate surgery. Preoperative frailty scales may help to stratify patient risk and the adoption of minimally invasive surgical techniques and percutaneous treatments may reduce procedural morbidity.

Regardless of patient age though, preoperative consultation must focus on clearly identifying the goals of surgery and determining whether or not they align with the patient's treatment goals.

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