

Neuro-Oncology Practice resources for optimizing care and practice in spinal oncology

Vikram B. Chakravarthy, Matthew M. Grabowski, Edward C. Benzel, and Deborah L. Benzil

Department of Neurosurgery, Cleveland Clinic of Case Western Reserve School of Medicine, Cleveland, Ohio (V.B.C., M.M.G., E.C.B., D.L.B.)

Corresponding Author: Deborah L. Benzil, MD, Department of Neurosurgery, Cleveland Clinic of Case Western Reserve School of Medicine, 9500 Euclid Ave, Cleveland, OH 44195 (benzild@ccf.org).

Abstract

As the diagnosis and treatment of systemic cancers continues to improve, increased patient survival has resulted in a rise in the number of patients who develop spinal metastases (SM). Within many areas of oncology, utilization of multidisciplinary care models in the management and decision making of SM patients has proven effective for optimizing care and improving patient safety. Three main goals of an effective clinical pathway include improving outcomes and quality, improving the patient experience, and lowering cost. This paper outlines the strategies employed to optimally establish such a collaborative program for the management of patients with SM, as well as direct providers in and out of the field, patients and caregivers, and practice managers to the appropriate resources.

Keywords

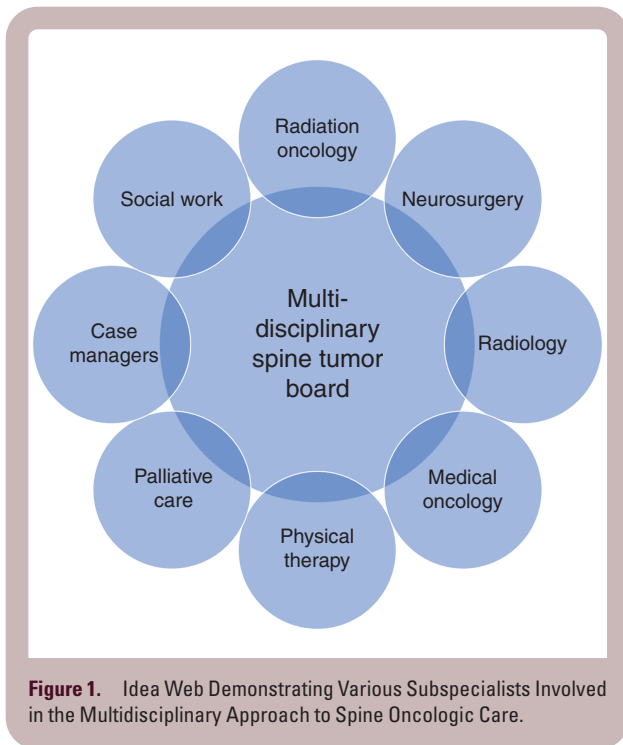
multidisciplinary care | programmatic approach | resource utilization | spinal oncology | spine radiosurgery

As the diagnosis and treatment of systemic cancers continues to improve, increased patient survival has resulted in a rise in the number of patients who develop spinal metastases (SM).¹ Approximately 30% of patients with systemic cancer develop SM, and the complexity of these tumors and potential for neurological involvement has contributed to historically poor outcomes for this patient population, with a median overall survival of 10 to 11 months.^{1,2} Contributing to the morbidity and mortality of patients with SM are the challenges facing providers to coordinate and deliver the multidisciplinary care that is necessary to effectively manage such complex patients.²

Three main goals of an effective clinical pathway are improving outcomes and quality, enhancing the patient experience, and lowering cost.³ To achieve these goals, an ideal program may make use of a variety of treatment strategies in a multimodal approach, integrating surgery, chemotherapy, conventional and stereotactic radiation therapy, as well as deciding how best to involve supportive and allied health care. Multidisciplinary care models are necessary for the management and decision making of SM patients to provide optimal

patient-centric care that effectively addresses the multitude of factors that influence patient morbidity, mortality, and quality of life (QOL, [Figure 1](#)). For example, one study found that after establishment of a multidisciplinary clinic, there was a decrease in time from diagnosis of lung cancer to first oncology assessment (12.4 days to 3.9 days) and time from diagnosis to first cancer treatment (39.5 days to 15.0 days).⁴ These approaches can also help ensure that patients have access to the most appropriate treatment at the optimal time. Finally, they can help bridge the silos between specialists, such as in academic/private separations within communities or between radiation/medical oncologists, surgeons, and other cancer providers.

This paper will outline how to optimally establish such a comprehensive, collaborative, patient-centered program for management of SM. Key concepts will be discussed along with options for implementation. This guide should prove beneficial to specialists, general physicians, patients, caregivers, and administrators involved with these types of programs. A comprehensive flowchart for patient assessment will be provided along with a discussion about key elements related to value. Finally, a



general roadmap to program development and implementation will be provided.

Keys to Program Establishment

- Capacity for rapid and high quality radiological and pathological evaluation and diagnosis
- Well-defined ability for flexible team involvement
- Standardized, institutional care paths (management flowcharts that remain current with best practices)
- Optimization of HIPAA (Health Insurance Portability and Accountability Act) compliance within the multidisciplinary team
- Regularly scheduled multidisciplinary spine tumor board meetings with additional ad hoc capacity
- Open dialogue with community oncologists/primary care physicians (PCPs) to facilitate access and rapid treatment with advanced treatment modalities and/or clinical trial enrollment at larger centers
- Program configuration that reflects local needs and that best promotes collaboration across health systems and practices (Open and closed programs may meet this requirement)
- Availability of various advanced treatment modalities, such as spinal stereotactic radiosurgery (SRS) and minimally invasive surgery, that maximize benefit while minimizing recovery and side effects
- Participation in local, regional, and or national clinical trials to offer patients options and become a referral center
- Priority given to maintaining a patient-centric approach to treatment, with goals and guidance focused on attaining the best QOL for each patient.

- Integration of complementary services including nutrition, mindfulness, and family support along with palliative care and hospice services throughout the course of treatment

Optimal Diagnosis Capacity

The capacity for rapid and accurate diagnosis, including a subspecialized radiology and pathology service, must be of high priority. Given enhanced patient survival, the experience of both predictable and unpredictable histopathologic mutations and radiologic growth patterns are of paramount importance. In addition, increased survival naturally leads to extended periods of radiological surveillance (see case 1), requiring continuity of care across all domains. All other treatment interventions hinge on this first step in program development.

Standardized Institutional Care Paths and Care Delivery Models

Whereas traditional cancer centers have largely been based on brick and mortar structure, SM programs are less amenable to this singular approach for a variety of reasons. The multidisciplinary approach brings providers from different spheres of health care into the same arena, leading to innovative treatment modalities and care pathways. These providers should define the scope of the program to best fit their institutional resources and patient demographics. Although it is acceptable to model this based on preexisting spine tumor programs, it is important to personalize it to best fit for the individual institution.

To expedite care, improve outcomes, and lower costs, many hospital systems have tried to develop different models of oncologic care delivery to patients. One such model commonly used is the use of care pathways integrated into their practice.⁵ Vanhaecht et al has defined a care pathway as “a complex intervention for the mutual decision-making and organization of care processes for a well-defined group of patients during a well-defined period.”⁶ Typical care paths for SM direct evidence-based treatment options in a flowsheet-type manner based on details about the cancer type, location, neurological exam, and other clinical characteristics, and can recommend treatment modality, timing, sequence, and dosing.⁷ This provides a variety of benefits to the center, ensuring a more straightforward, standardized delivery of complex care in SM patients. Studies have suggested that patients in other types of cancers who received care path-consistent treatment had reduced lengths of hospital stay, reduced hospital costs, and improved patient outcomes with reduced complications.^{8,9} Criteria have also been developed to objectively evaluate care pathways, including clinician and allied health professional involvement during development, evidence-basis, transparency, clinical decision support via integration into electronic medical record systems, and bioinformatics/analytics for quality improvement.^{10,11} An excellent example of a comprehensive care

pathway system for head and neck cancers has been published.⁵ Other additional improvements to care delivery have been designed including patient/family navigation, such as the Patient Care Connect Program, which assigns a unique patient navigator to guide and direct each patient during their treatment at 12 cancer centers in 5 states. This model, using a care navigator, was associated with fewer hospitalizations, including ICU admissions, fewer emergency department visits, and lower costs when comparing navigated and nonnavigated patients.¹²

Efficient, rapid HIPAA compliant communication is a cornerstone of any successful SM program. There are multiple “doors of entry” into a SM program that pose unique challenges both for patients and physicians. Establishing flow of imaging, pathology, and laboratory results as well as prior interventions (including detailed radiation plans) must be considered for the SM team to create best practices for the patients.

Clinical Decision Making—the Role of the Multidisciplinary Spine Tumor Board

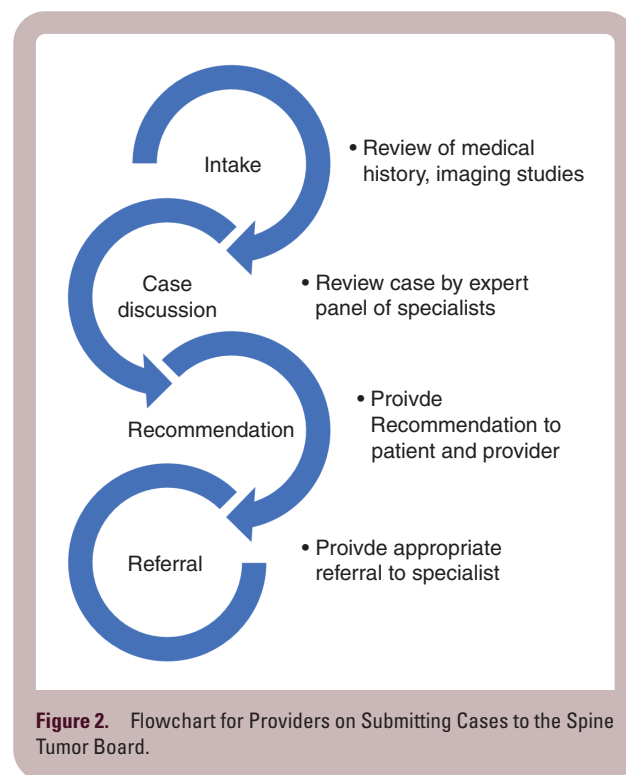
While palliative, treatment goals for SM patients encompasses a variety of outcomes, including preserving or restoring neurologic function and/or ambulation, safeguarding of spinal stability, providing durable local tumor control, and improving QOL.¹³ Clinical decision making in SM patients involve the objective assessment of a complex variety of patient-specific factors, including the evaluation of the primary tumor histology and molecular markers, dissemination of the systemic disease, location of the SM(s), neurological status, and pain, as well as the ability to predict the probability of disease progression and neurological worsening, benefits/risks of each treatment, and expected patient survival.¹⁴ Although the specific management guidelines are beyond the scope of this manuscript, input is required from multiple disciplines to provide the complex physical, psychological, and social care needs of these patients. Optimally this includes, but is not limited to surgeons (neurosurgery, orthopedic surgery, surgical oncology), medical oncology, radiation oncology, radiology, interventional pain specialties, physical and rehabilitation medicine, physiatrists, experts in bowel and bladder care, back care and ambulation support, physical and occupational therapy, psychological and/or social services, and nutritional support.¹⁵ This underscores the importance of an effective multidisciplinary spine tumor board.¹³

The NCI defines *tumor board review* as a treatment planning approach in which experts in different specialties review and discuss the medical condition and treatment options of a patient.¹⁶ Optimal management of spine tumors requires a multidisciplinary team and each center has a spine tumor board that meets regularly, to review cases and provide efficacious, multimodality treatment recommendations that are in keeping with the current literature in the field. Effective programmatic development requires a care coordinator to receive and gather all relevant clinical information and catalog cases for discussion. Pertinent clinical information includes initial history and presentation, prior and current

chemotherapy and radiation cycles, complications from therapy, and involvement and eligibility in clinical trials. Newer iterations of tumor boards now focus on molecular markers and next-generation sequencing, recommending targeted therapies for patients based on the tumor’s genetic signature.¹⁷ As important as these clinical variables is the determination of goals of care for each patient, as these should be discussed to inform the aggressiveness of care. We have developed several flowcharts to guide patients and providers in this realm. **Figures 2 and 3** demonstrate care pathways for providers and patients respectively once they refer a case to the spine tumor board for discussion. The role of care coordinators to facilitate this process and provide support to the PCP is essential for optimal health care delivery. **Figure 4** provides a flowchart for providers to navigate both the nonoperative and operative domains.

Initially, it is important to discuss all cases of spinal oncology, not just the “unique cases” that give surgeons pause. Growth of the program and/or volume of the institution allows coordinators to subdivide cases for more focused discussions (ie, primary spine tumors vs SM). Studies by Kesson et al and Petty and Vetto support the notion that tumor boards affect patient care.^{18,19} In fact, Kesson and colleagues reviewed their 14 358 cases, noting that multidisciplinary care was associated with improved survival and reduced variation in survival among hospitals.¹⁸

Secondary benefits of an effective SM program allow for establishment of an oncologic database that can serve as a repository for research and scholarly activity. Rangabashyam et al detail this benefit in their review of their own data collection system and the evolution of a head and neck tumor board.²⁰ Additional benefits include



identifying various quality improvement and patient safety issues. Key to this process is effective communication between providers, allowing for comprehensive collaboration. Bringing experts from different specialties with unique thought processes promotes innovation and excellence. A comprehensive SM program is essential for the effective management of these complex patients.



Figure 3. Flowchart for Patients on Submitting Cases to the Spine Tumor Board.

Broad-Based Community Collaboration

Given the evolution of communication methods, the recent COVID (coronavirus disease 2019) pandemic has illustrated the lasting impact virtual communication has on the changing face of medicine. A growing trend in patient care is to allow chronic oncologic management to take place in regional and community settings, whereas dynamic interventions and clinical trials take place at the larger referral centers.⁷ The role for virtual tumor boards and the ability for providers to participate from all regions enhances the health care delivery of tumor boards and growth of the referral network. This may prove especially effective in resource-limited countries or regions.²¹ In addition, it allows for rapid throughput of patients, enabling treatment plans to be enacted efficiently. Encouraging all providers within a health group or system to submit cases for review and actively participate in the discussion is optimal. Strategies also exist for the institution of the multidisciplinary tumor board in the community practice setting.²² This may prove valuable in a health system with regional and referral centers where patients can obtain the majority of their care close to home. In open programs the care coordinator plays the vital role of communicating to primary providers the results of multidisciplinary discussions and following up if patients may become eligible for clinical trials. A clear mechanism of case submission and transmission of key data along with the mechanism for response communication is critical.

The choice of an open vs closed program is entirely dependent on regional needs and traditions. Some argue that closed programs (in which only select/inside individuals are permitted to provide certain care interventions) promote high quality. Realistically, an open program will likely foster collaboration that can be paired with careful

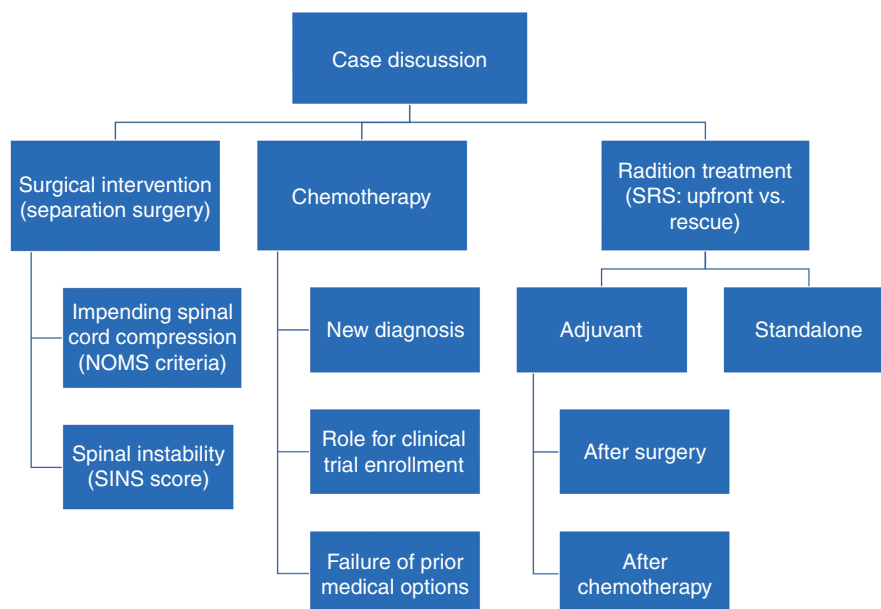


Figure 4. Flowchart Demonstrating a Multimodality Care Path.

certification for specialized interventions. Spine SRS is an example whereby those radiation oncologists, physicists, and neurosurgeons should be required to demonstrate education, experience, and competence before providing this type of intervention.

Advanced Treatment Modalities—the Value of Spine Stereotactic Radiosurgery

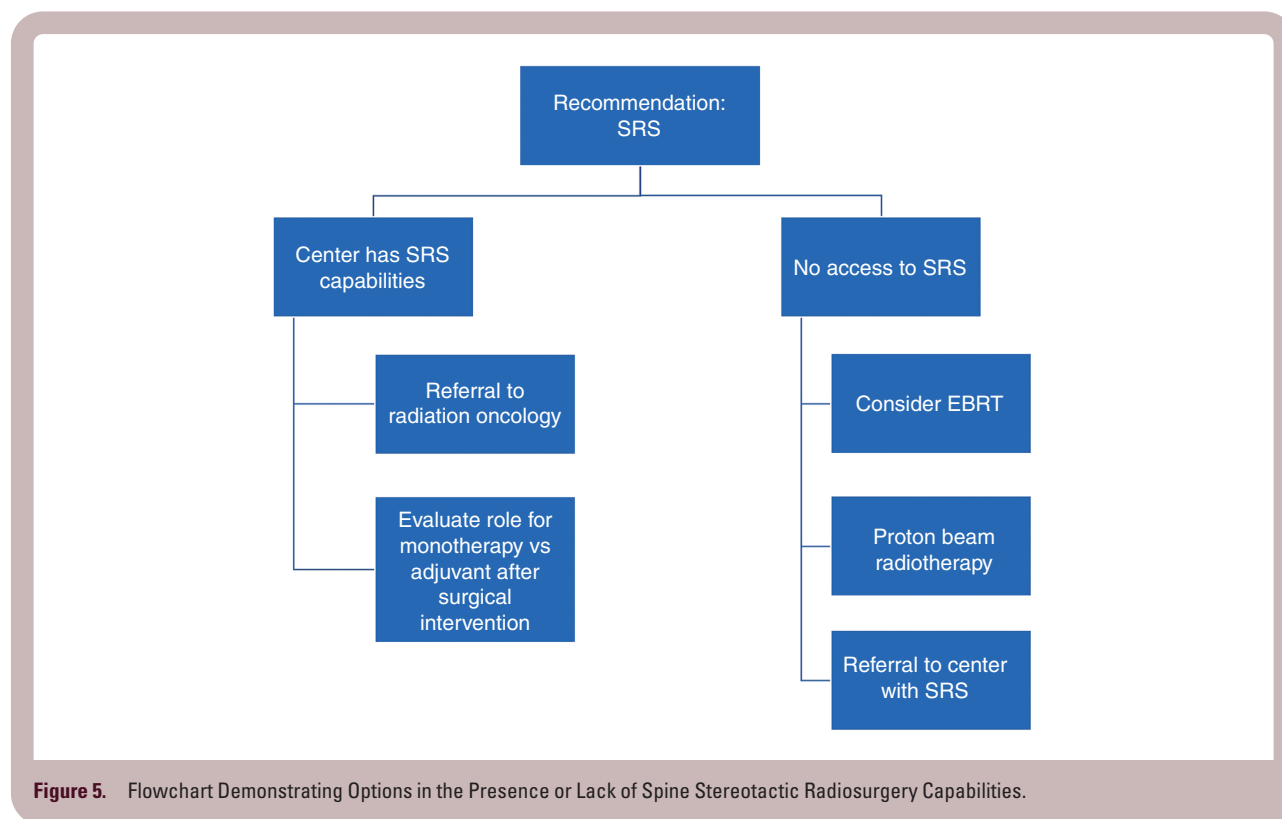
The development of SRS for treatment of tumors of the spine has had a significant impact on the QOL and clinical outcomes of these patients.¹⁴ Spine SRS (SSRS) allows for the delivery of a high tumoricidal dose to the target while sparing adjacent normal tissues, such as the spinal cord, and surmounts the resistance often seen with conventional fractionated radiation treatments.²³ SSRS provides a dual benefit, resulting both in excellent and durable spine tumor control and significant pain relief in patients with oncologic pain. Studies have demonstrated tumor control rates greater than 90%, as well as 84% to 100% pain improvement even in patients with mild epidural involvement.^{24–28} Moreover, despite the significant comorbidities related to spine tumors and their systemic disease burden overall, many patients often have rapid improvement in symptoms and QOL thanks to the noninvasive, outpatient nature of the procedure.^{29–31}

Although the concept of real value across medicine may remain elusive, within the realm of oncologic care, there is a clear argument for the value of SSRS. Offering the ability to provide patients outpatient therapy that allows for local tumor control while minimizing the role of surgical

treatment. In addition, the ability to complement minimally invasive surgical techniques allows patients to have shorter hospital stays. Popularized through data from and strategy developed at Memorial Sloan Kettering Cancer Center, hybrid therapy involving separation surgery plus adjuvant SSRS is a technique to separate the pathologic disease from the normal spinal cord to allow for greater precision of high-intensity stereotactic radiosurgery.³² With the utilization of separation surgery, greater surgical intervention focuses on decompression of the spinal cord/thecal sac, minimizing surgical morbidity and shortening the postoperative course prior to starting physical therapy. Given the decreased complication rate in nonfusion procedures, it also minimizes potential barriers to SSRS. This further emphasizes the need for close collaboration of these 2 procedures that may be performed by independent teams.

The majority of SSRS procedures are performed at high-volume, experienced centers with an integrated spine tumor team comprising dedicated spine tumor radiation oncologists, spine surgeons, physicists, and therapists, all familiar with the complexities related to treating the oncologic and mechanical manifestations of disease in spine tumor patients.^{33,34} This multidisciplinary approach is important because the tumoricidal effects of SSRS are not immediate, and even in a high-volume center with a robust infrastructure, the time from consultation to SSRS treatment delivery can average 12 days, during which permanent neurologic deficits can occur.³⁵

An integrated SSRS program offers many advantages to the patient, community, and physicians while strongly supporting value and quality. [Figure 5](#) demonstrates a



flowchart for centers that may or may not have access to SRS technologies.

Palliative and Hospice Care

Members of treatment teams should become aware of the complexity of care as well as the palliative and hospice resources available in their community. Team members should strive to help educate patients and their families that these services do not imply abandonment, futility, and lack of treatment options for the disease. These resources can be of immense value to patients and their families, and as such, should be provided early on in the disease course, integrated into the comprehensive management for SM patients.¹⁵ This is increasingly being recognized as a crucial component of care that improves QOL at the time of diagnosis and beyond.⁷

Patient and Caregiver Information

Patient information.—Many institutions provide excellent resources for patients and providers regarding SM. A few notable ones include the following:

- Cleveland Clinic: <https://my.clevelandclinic.org/departments/cancer/depts/spine-tumor>
- Memorial Sloan Kettering: <https://www.mskcc.org/cancer-care/types/spine-tumors>
- The MD Anderson Cancer Center: <https://www.mdanderson.org/cancer-types/spinal-tumors.html>
- Massachusetts General Hospital: <https://www.massgeneral.org/orthopaedics/oncology/conditions-and-treatments/metastatic-bone-tumors-of-the-skeleton>
- Duke Health: <https://www.dukehealth.org/treatments/cancer/metastatic-brain-and-spine-tumors>

In addition, several companies that are involved with technology related to SM including BrainLab (Novalis) and Accuray (CyberKnife) have sites with noninstitutional-based information. The American Cancer Society and the American Society for Radiation Oncology have significant resources available for patients, families, and physicians. In addition, for those with specific tumor types, there are outstanding sites such as Gilda's Club and the Chordoma Foundation that can serve as excellent resources.

- BrainLab (Novalis): <https://www.brainlab.com/for-patients/>
- Accuray (CyberKnife): <https://www.accuray.com/cyberknife/cyberknife-resources/>
- American Cancer Society: <https://www.cancer.org/>
- American Society for Radiation Oncology: <https://www.astro.org/Patient-Care-and-Research/Patient-Education>

Additional information on specific topics includes the following:

Rehabilitation³⁶
SSRS^{37,38}

Case Studies

Case 1

A 35-year-old woman presented to her PCP with a 3-month history of low back pain and intermittent bowel and bladder incontinence. She had presented to the emergency department 2 times with minimal workup. During this encounter, a CT of the lumbar spine demonstrated a sacral mass that has eroded ventrally into the retroperitoneal region and dorsally into the sacral ala. She was admitted and a subsequent MRI further characterized the mass. Additional imaging studies were negative for other sites of disease. She undergoes a CT-guided biopsy of the sacral mass, which on initial review was nondiagnostic. She was then referred to a neurosurgeon at the nearest tertiary care center. On further review by subspecialty histopathologists, a diagnosis of chordoma is confirmed. As the neurosurgeon plans for surgical resection of this lesion, he is limited by not knowing the exact approach of the biopsy and how best to include it in the current surgical plan. In addition, a biopsy may not have been the preferred step in management as recommended by the spine tumor board.

Case 1 Teaching Point

The benefit of a virtual tumor board would allow for open discussion of various spine oncologic cases. Even in settings where onsite subspecialty surgeons are not present, involvement of referring providers early in the disease course allows for efficient and seamless health care delivery. In this case, had there been a discussion prior to performing the biopsy, the referring surgeon could have guided the proceduralist to tag the biopsy track and maximize the potential for en bloc surgical cure. In addition, the role of the pathologist and radiologist is vital in the first step of development of a spine tumor program. At times there can be ambiguity in reviewing pathology specimens based on the location of the biopsy and after patients have undergone adjuvant therapies. In addition, multimodality therapy has led to increased survival among patients, necessitating the role for cutting-edge subspecialty care.

Case 2

A 55-year-old man with history of lung cancer presented to an outside hospital with progressive lower extremity weakness and neurogenic claudication. Over the last several weeks he had increasingly been using a cane for ambulation. An MRI was performed demonstrating a midthoracic metastatic lesion involving the T7 vertebral body with epidural disease-causing spinal cord compression. A CT scan demonstrates a T7 compression fracture involving both the vertebral body and unilateral pedicle, causing focal kyphosis at the involved segment. Based on the clinical presentation and imaging studies, the patient undergoes a T6 to T8 decompression and T4 to T10 instrumented pedicle screw fixation. He is given a referral to follow-up with

Radiation Oncology at the nearest tertiary care facility for adjuvant SSRS. After several weeks of suboptimal follow-up, he is finally seen by Radiation Oncology for radiation planning. Updated imaging studies performed at that time demonstrate recurrence of disease in the T7 epidural space with ventral compression. Given the disease recurrence, a discussion of the spine tumor board recommends repeat surgical resection prior to adjuvant radiation to minimize spinal cord toxicity.

Case 2 Teaching Point

A significant challenge in oncologic care is coordination. When patients present with metastatic compressive lesions, the most important task at that time point is to relieve spinal cord compressive to preserve neurologic function. However, this is only one piece of the larger treatment algorithm, which includes chemotherapy and adjuvant SRS. Popularized by Barzilai et al at Memorial Sloan Kettering Cancer Center, hybrid therapy (separation surgery plus adjuvant SSRS) is a technique to separate the pathologic disease from the normal spinal cord to allow for greater precision of high-intensity SRS.³² In the presented case, lack of coordinated follow-up led to tumor recurrence and delay in setting up adjuvant therapies. To promote greater care coordination, a comprehensive spine tumor program with regional collaboration will help facilitate patient follow-up and minimize delays in adjuvant care. In addition, this would keep the ownership with the regional surgeons but provide a seamless avenue for urgent oncologic referrals.

Conclusions

A multidisciplinary approach to spine oncologic care is essential to ensure all available resources are used for optimizing delivery of specialized care. Given the rapidly progressive landscape, a spine tumor board that brings together experts from various oncologic domains enhances the individualized care provided to patients. Although challenges in the treatment of spine tumors exist, the value of team-based care enhances the quality of care and helps to identify patient safety concerns that may exist. In developing an individualized spine tumor program, identifying available resources and supplementing these with virtual platforms are paramount to growth and sustainability.

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