

Management of Spinal Tumors: Physical Therapy Implications and Interventions

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Learning Objectives

- To gain a general knowledge of both primary and metastatic spinal tumors
- To review the various medical and surgical treatment options for patients with spinal tumors
- To discuss the implications of rehabilitation's vital role within the multi-disciplinary care team for patients with spinal tumors
- To identify safe and appropriate interventions and strategies throughout the continuum of care for this patient population

Overview of Primary and Metastatic Spinal Tumors

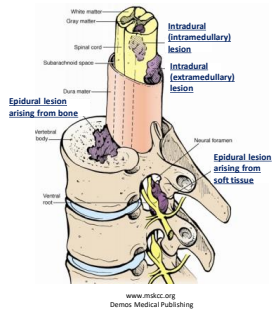
Spinal Tumors^{1,2,3,4}

- Primary spinal tumors: masses of abnormal cells originating in the spinal cord, dura, or the vertebral bodies that grow out of control
- Metastatic spinal tumors: cancer cells originate in another area of the body and spread to the spinal cord, dura, or vertebral bodies via the bloodstream or lymph vessels

Anatomical Classification^{1,2}

- Intradural – within dura mater
 - Intramedullary – within spinal cord
 - Extradural – outside spinal cord
 - Most often primary spinal tumors
- Extradural – outside dura mater
 - Often arise in bony vertebrae
 - Most common site for spinal tumors
 - Most often metastatic spinal tumors

Spinal Tumors



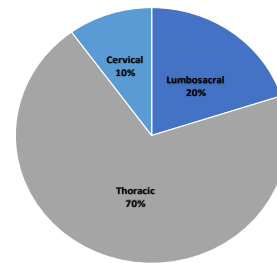
Histological Classification^{1,3,5,6}

- Intradural
 - Primary intramedullary
 - Benign
 - Ependymoma
 - Hemangioblastoma
 - Malignant
 - Astrocytoma
 - Primary extramedullary
 - Benign
 - Meningioma
 - Nerve sheath tumor (schwannoma, neurofibroma)
- Metastatic
 - Leptomeningeal disease (LMD)

Histological Classification^{6,7,8}

- Extradural
 - Metastatic
 - Primary benign
 - Giant cell tumor (GCT)
 - Osteochondroma
 - Osteoid osteoma/osteoblastoma
 - Primary malignant
 - Chordoma
 - Chondrosarcoma
 - Osteosarcoma
 - Ewing sarcoma
 - Lymphoma
 - Plasmacytoma

Location of Spinal Tumors^{4,9}



Etiology^{1,5,10}

- Primary spinal tumors
 - Most tumors NOT linked to any known factors or causes
 - Genetics
 - Familial/inherited syndromes
 - Previous radiation exposure
- Metastatic spinal tumors
 - Lung cancer
 - Breast cancer
 - Prostate cancer
 - Renal cancer
 - Thyroid cancer
 - Multiple myeloma
 - Lymphoma

Statistics^{10,11}

- One person in 100,000 (~10,000) people per year develop spinal tumors
- 15-20% of all CNS tumors occur in the spine
- Primary spinal tumors
 - Benign tumors – 55-65% all primary spinal tumors
- Metastatic spinal tumors
 - Most common – 70% all spinal tumors
 - Spinal metastases occur in 20% of all patients with cancer
 - 5-10% develop spinal cord compression

Diagnosis^{1,10,12}

- Signs and symptoms
 - Pain
 - Weakness
 - Sensory symptoms
 - Impaired coordination
 - Bowel/bladder dysfunction
- Neurological exam
- Imaging
- Blood tests
- Biopsy*

Signs & Symptoms

- Pain Syndromes^{6,12,13,14}
 - Biological
 - Tumor related pain
 - Deep, gnawing, aching
 - Night or morning pain resolving over course of the day
 - Improves with activity or anti-inflammatories
 - Mechanical
 - Impending or existing spinal instability
 - Movement related pain – transitional movement, axial loading
 - Unresponsive to medical management
 - Radiculopathy
 - Pain (often radiating) from nerve root compression
 - Sharp, shooting, stabbing
 - Cervical – radiating unilaterally into UE
 - Thoracic – band-like bilaterally around chest/abdomen
 - Lumbar – radiating unilaterally into LE

Signs & Symptoms

- Myelopathy^{12,14}
 - Indicates high-grade spinal cord compression
 - Symptoms – dependent on tumor location
 - Pain
 - Weakness/paralysis
 - Loss of sensation (light touch, pin-prick, proprioception)
 - Abnormal reflexes
 - Impaired balance and coordination
 - Autonomic changes (bowel and bladder)

Treatment^{1,4,12,14}

- Primary spinal tumor
 - Goal of treatment → curative
- Metastatic spinal tumor
 - Goal of treatment → palliative
- Treatment options
 - Surgical resection
 - Radiation
 - Chemotherapy
 - Other drugs

Surgical and Medical Treatment Options

Spinal Tumor Treatments^{1,12,15}

- Advances in medicine, technology, and techniques have improved safety and effectiveness of treatment of spinal tumors
 - Surgery
 - Minimally invasive → complex procedures to remove tumors, decompress spinal cord, and stabilize spine
 - Radiation
 - Systemic therapy
 - Chemotherapy
 - Other drugs
 - Corticosteroids
 - Immunotherapy

Primary Spinal Tumors ^{2,12,15}

- **Surgery**
 - Dependent on distinct tumor border
 - Clear border: gross total resection → curative
 - Infiltrative tumor: subtotal resection +/- adjuvant therapy
- **Radiation**
 - EBRT, SBRT
 - Dependent on tumor histology, extent of resection, and recurrence
 - Most often utilized following incomplete resections or with high grade, infiltrative tumors
- **Chemotherapy**
 - Dependent on tumor histology, extent of resection, and recurrence
 - Limited role
 - Most often utilized with systemic involvement and in pediatric population

Metastatic Spinal Tumors ^{4,12}

- **Medical treatment options**
 - Radiation
 - EBRT, SBRT
 - Chemotherapy
 - Other drugs
- **Surgery**

Metastatic Spinal Tumors

- **NOMS – decision framework that facilitates treatment of metastatic spinal tumors⁴**
 - N - Neurologic
 - O - Oncologic
 - M - Mechanical instability
 - S - Systemic disease

Metastatic Spinal Tumors

- **Radiation ^{1,12}**
 - **EBRT**
 - Used for radiosensitive tumors regardless degree of cord compression
 - Lower dose, more fractions
 - Risk of RT-induced toxicity and side effects
 - **SBRT**
 - Used for radioresistant tumors
 - More precise: higher dose, less fractions
 - RT-induced toxicity rare, mild complications/side effects

Metastatic Spinal Tumors

- **Surgery ^{4,12}**
 - Dependent on
 - Mechanical instability
 - Degree of cord compression/neurological symptoms
 - **Radioresistant tumors – “separation” surgery**
 - Minimal tumor resection carried out to separate tumor margin from spinal cord
 - Role of surgery to create “target” for SBRT
 - Bulk of tumor treated with SBRT

Metastatic Spinal Tumors Treatment Framework

	Radiosensitive	Radioresistant
Low-grade ESCC	EBRT	SBRT
High-grade ESCC	EBRT	Surgery + SBRT

Surgical Procedures

- En-bloc resection
- Percutaneous cement augmentation
- Decompression with stabilization
- Sacrectomy

En-Bloc Resection^{1,12}

- Surgical technique removing tumor in a single piece
- Main goal = remove ALL cancer
 - Remove tumor + normal surrounding tissue → clear margins
- Often used to completely eliminate primary tumors
 - Complete resection correlates with progression-free survival

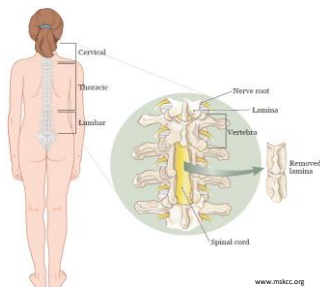
Percutaneous Cement Augmentation^{1,12}

- Minimally invasive procedure to treat vertebral compression fractures
 - Vertebroplasty – image-guided injection of bone cement into the fractured vertebra
 - Kyphoplasty – balloon-like device inserted/inflated to expand the compressed vertebra, space then filled with bone cement
- May require additional stabilization such as percutaneous screws for compression fractures extending past vertebral body

Decompression with Stabilization^{1,12}

- Relieves pressure on spinal cord and nerve roots
 - Often posterolateral approach - removing back part (lamina) of the vertebrae
 - Creates space to allow EBRT or SBRT without risking injury to spinal cord
- Spinal stability achieved by surgical fixation/fusion
 - Pedicle screws and/or rods redistribute stress and maintain alignment of bones
 - Needed with significant spinal cord compression, collapsed vertebra, or severe burst fractures

Laminectomy



Spinal Post-op Precautions

- Spinal precautions - activity restrictions to promote safe mobility and allow healing
 - Activity restrictions (No BLT)
 - No **B**ending (forced flexion/extension of spine)
 - No **L**ifting > 5-10lbs.
 - No **T**wisting of spine
 - Additional ROM restrictions for cervical → upper/mid thoracic surgery
 - No reaching overhead
 - No horizontal adduction past midline
- Generally followed 5-6 weeks post-op

Sacrectomy¹²

- Partial to complete removal of the sacrum to effectively remove/debulk tumors of the sacrum
- Resection of sacral nerve roots
 - Partial – removal of only a portion of the bony structure of the sacrum and potentially nerves
 - Complete – removal of the entire sacrum AND the nerves
- Reconstruction
 - Wound closure from rectus abdominus muscle flap
 - Spinal instrumentation and bone grafts

Sacrectomy Post-op Precautions

- Activity determined by wound closure
 - Pressure-relieving mattress
 - No SITTING (6 weeks)
 - No supine (rare)
- WB status – WBAT
- Orthostatic hypotension

Post-op Complications^{5,12,14}

- Wound healing issues
 - Infection
 - Dehiscence
- DVT/PE
- CSF leak
- Neurological injury
- Pulmonary complications
- Hardware migration/failure

Rehabilitation of Patients with Spinal Tumors

Role of Rehabilitation^{13,16,17}

- Rehabilitation of patients with spinal tumors focuses on relieving symptoms, improving quality of life, enhancing functional independence, and preventing further complications.
 - Impairments may be caused by the cancer, treatment side effects, and/or co-morbidities
- Prognosis, POC, and goals of patient dictate rehab interventions and recommendations
- Multidisciplinary team approach
- Patients CAN and WILL be encountered in any rehab setting!

Role of Rehabilitation

- Functional mobility
- Pain management
- Bracing
- Neuromuscular re-education
- ROM/flexibility
- Strengthening
- Bowel/bladder management

Functional Mobility

- Promoting safe and efficient mobility to maintain and maximize patients' function along the continuum of care
 - General mobility techniques
 - Maintaining spinal precautions
 - With spinal disease
 - Post-op
 - Post-sacroctomy precautions

Functional Mobility

- PT interventions
 - Positioning
 - For skin and joint integrity
 - Bed mobility
 - Functional transfers
 - Gait training
 - Adaptive equipment, assistive devices, DME
 - Cushion, wheelchair fit and train
 - Patient and caregiver education

Pain Management^{9,16}

- Multidisciplinary approach to medical management of pain
- Variety of medications to address different types of pain
 - Incisional pain
 - Opioids, NSAIDS
 - Neuropathic pain
 - Gabapentin, Lyrica
 - Muscle spasms
 - Baclofen, Botox

Pain Management^{12,17}

- Pain often most limiting barrier for successful rehabilitation
- Role of PT - dependent on
 - Type of pain
 - Physical impairments
 - Cancer-care continuum
 - Treatments received
 - Future POC
 - Prognosis
 - Co-morbidities

Pain Management⁶

- PT interventions
 - Positioning
 - For comfort
 - Postural bracing
 - Modalities
 - Heat, cold
 - TENS
 - Manual therapy
 - Soft tissue massage

Bracing¹³

- Bracing serves as a conservative care measure or as an adjunct to medical and interventional management
- Brace selection based on
 - Individual patient need
 - Medical and oncologic status
 - Surgical status and stability
 - Goals and mobility

Bracing¹³

- Indications
 - Flexible, supportive, or rigid bracing for
 - Postural correction
 - Strengthening or stretching
 - Proprioceptive awareness
 - Stabilization of fractures

Bracing¹³

- Cervical collars
 - Soft cervical collar
 - Hard cervical collar
- Clavicle strap
- TLSO
- Multipodous boot
- AFO
- Additional support
 - Abdominal binder
 - Compression stockings

Cervical Collars¹³

- Soft cervical collar
 - No concern of mechanical instability
 - Comfort, postural support
 - Worn as needed
- Hard cervical collar
 - Mechanical instability present
 - Limits cervical motion
 - Best limits flexion/extension
 - Worn at all times vs for OOB mobility

Cervical Collars

- Soft cervical collar
- Hard cervical collar



Clavicle Strap¹³

- Facilitates upright posture and restores more optimal alignment of the head, shoulders, and thoracic spine
- Provides gentle reminder to retract shoulders
- Gradual stretching of anterior chest musculature and strengthening of back musculature



TLSO¹³

- Prescribed for thoracic fractures and multi-level compression fractures of thoracic and lumbar spine
 - TLO, LSO for less extensive multi-level fractures
- Restricts flexion/extension, side-bending of spine
- Assists in pain management, muscle fatigue, and postural correction
 - Promotes safe core strengthening and body mechanics

TLSO/LSO

TLSO



LSO



Multipodus Boot

- Positioning brace while in bed
- Promotes neutral alignment of foot drop
 - Provides gentle DF stretch of ankle
 - Prevents PF contracture
- Maintains skin integrity



AFO

- Supports and stabilizes weak ankle and foot during mobility and ambulation
- Provides proprioceptive input during weight bearing
- Off-the-shelf vs custom options



Additional Support

- Abdominal binder
 - Utilized for cervical and upper thoracic injury
 - Enhances postural support
 - Improves efficiency of respiration
 - Minimizes effect of orthostatic hypotension
- Compression stockings
 - Improves LE circulation – reduces blood pooling
 - Minimizes effect of orthostatic hypotension

Neuromuscular Re-education

- Postural re-education
 - Addressing missing components during functional activities
 - Facilitating neutral alignment
 - Facilitating trunk and pelvic control
 - Progressing from static mobility to dynamic activity
 - Sitting → standing → functional
 - Pre-gait training

Neuromuscular Re-education

- Balance
 - Manipulating proprioceptive input
 - Supported → unsupported activities
 - Stable → unstable surfaces
 - Altering BOS
 - Removing visual input
 - Compression/bracing/weights to assist in controlling movement
- Functional use of tone

ROM/Flexibility

- Keep spinal ROM to functional, pain-free limit in post-op patients
 - Ok for limited cervical spine rotation to complete ADL and functional activities safely
- Once cleared by MD gradual progression of ROM and flexibility exercises for neck and back
 - Pain guides progression
 - Focus on returning patient back to activity level appropriate for them
 - Very individualized!

ROM/Flexibility

- Continuous passive stretching exercises on limbs as tolerated
 - Muscle tightness
 - Consider hip flexors, hamstrings, heel cords
 - Spasticity
 - Joint ROM
- Splinting/bracing
 - Muscle weakness
 - Muscle/joint tightness
 - Spasticity

Strengthening

- Clear communication with surgeon and physiatrist imperative before initiating strength training
 - Post-surgical patients may be progressed more conservatively than non-surgical patients.
 - Pain ALWAYS limiting factor
 - Post-surgical patients
 - No spinal muscle or core strengthening x 5-6 weeks post-op
 - OK for light LE strengthening
 - After 5-6 weeks – cleared for gradual strengthening
 - Isometric → progressive resistive exercises
 - No heavy weight recommended

Strengthening

- Progressive resistive exercises
 - Upper and lower extremities
 - Scapular/shoulder girdle
- Core – often most important to improve pain, posture, and diminish bracing needs
 - Abdominal muscles
 - Paraspinal muscles
 - Pelvic floor muscles
- Progress level of difficulty by altering position, BOS, and/or surface

Bowel and Bladder Management^{6, 12, 16}

- Based largely on level of injury, current function, and anticipated recovery
 - Incomplete vs complete spinal cord injury
- Classified as upper motor neuron (UMN) or lower motor neuron (LMN) dysfunction
 - UMN
 - Injury above conus medullaris
 - Hyperreflexic (spastic)
 - LMN
 - Injury below conus medullaris
 - Hyporeflexic (flaccid)
- Important to address skin integrity (high risk for skin breakdown and pressure ulcers)

Neurogenic Bladder^{6,9,12,16}

- Symptoms
 - Urgency
 - Frequency
 - Retention
 - Incontinence
 - Frequent UTI
- Management
 - Voiding schedule
 - Catheterization techniques
 - Indwelling
 - Intermittent
 - Fluid intake maintenance
 - Medications
 - Pelvic floor therapy

Neurogenic Bowel^{6,9,12,16}

- Symptoms
 - Constipation → impaction
 - Incontinence
- Management
 - Voiding schedule
 - Effective bowel evacuation
 - Digital stimulation
 - Manual removal
 - Diet
 - Medications
 - Positioning
 - Pelvic floor therapy

Pelvic Floor Therapy (PFT)⁶

- Considered for sensory retraining, pelvic muscle and sphincter coordination, and biofeedback
 - Dependent on severity of injury
- Re-educating pelvic floor muscles to contract AND relax to void and defecate efficiently.
- UMN – relax muscles
 - Diaphragmatic breathing
 - Positioning
 - Gentle stretches
- LMN – strengthen muscles
 - Muscle agility
 - Muscle endurance

Rehab Considerations Across the Continuum

- Rehabilitation of patients with spinal cord tumors is essential^{9,17}
 - Advances in treatment → increased survivorship!
 - Increased survivorship → NEED for rehabilitation services!
- Research shows the positive effects of inpatient rehabilitation on these patients' function and QOL

Literature Review

- McKinley WO, et al, 1999
 - Prospective comparison study
 - Compared outcomes of patients with neoplastic SCC vs traumatic SCI after inpatient rehab
 - Main outcome measures
 - Hospital/rehab LOS
 - FIM scores
 - Rate of DC home
 - Neoplastic SCC → significantly shorter rehab LOS; significantly lower DC FIM scores
 - Neoplastic SCC can achieve rates of functional gain comparable to traumatic SCI
 - Similar DC rates home

Literature Review

- Ruff RL, et al, 2007
 - Prospective comparison study
 - Compared paraplegic patients who received 2 weeks of directed rehab with control group who received no directed rehab
 - Main outcome measures
 - Survival
 - Longer median survival
 - Independence
 - 67% rehab group independent with transfers (vs 0% control group)
 - 75% rehab group DC home (vs 20% control group)
 - Pain levels
 - Lower pain rating
 - Depression/satisfaction of life
 - Lower depression scores
 - Higher satisfaction of life scores

Case Study 1

Case Study 2

Conclusion

- “As survival after treatment for spinal cord tumors improves, it is important to understand how to apply rehabilitation principles and practices to this patient population.”^{9, 16}
 - It is important to have an understanding of primary and metastatic spinal tumors, including the various treatment options that will affect physical therapy’s role.
 - Clear communication and collaboration between the multidisciplinary team is crucial.
 - Physical therapy interventions, when utilized safely and appropriately, can greatly impact function and QOL.

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