Orthopedic Oncology: Complex Adult and Pediatric Cases

Amanda Molnar, PT MSPT
Regine Souverain, PT, DPT, C/NDT, PCS
APTA Combined Sections Meeting
Saturday, February 24, 2018

The presenters have no conflict of interest to report regarding any commercial product/manufacturer that may be referenced during this presentation.

All photos/illustrations are used with permission.

Photos/illustrations are for the sole use of educational purposes and are not to be replicated or redistributed in any manner.

Learning Objectives

• To gain knowledge of the general indications and surgical approaches of the most complex procedures utilized for treatment of soft tissue and bone tumors
• To understand the unique precautions and restrictions required following these complicated orthopedic procedures
• To identify safe and appropriate rehabilitation interventions and strategies when working with this patient population
• To better understand the need of physical therapy along the continuum of care for these patients immediately post-op, during their cancer care, and beyond

ORTHOPEDIC INTERVENTION FOR TUMOR INVOLVEMENT

Indications for Surgical Intervention

• Primary sarcomas
• Other primary cancers
• Metastatic bone disease
• Benign bone and soft tissue tumors

Primary Sarcomas

• Primary bone sarcomas: cancer which originates in the bone tissue itself
  – Osteosarcoma
  – Chondrosarcoma
  – Ewing sarcoma

• Primary soft tissue sarcomas: cancer which originates within soft tissues of the body
  – Pleomorphic sarcoma
  – Leiomyosarcoma
  – Liposarcoma
Other Primary Cancers

- Multiple myeloma
  - Originates in plasma cells in bone marrow found within bone
- Non-Hodgkin lymphoma
  - Generally develops in lymph nodes
  - Can originate in lymphocytes in bone marrow found within bone
- Tumors can cause bone destruction
- However, NOT considered primary bone cancer

Metastatic Bone Disease

- Cancer cells that break off from a primary tumor and spread to the bone via the bloodstream or lymph vessels
- More common than primary bone cancers in adults
- Risk factors – variable
  - Primary cancer
  - Size of existing tumor/s, grade of cancer, extent of metastases

Benign Tumors

- Benign bone tumors
  - Osteoid osteoma
  - Osteoblastoma
  - Osteochondroma
  - Enchondroma
  - Chondromyxoid fibroma
  - Fibrous dysplasia
- Benign soft tissue tumors
  - Lipoma
  - Leiomyoma
  - Fibroma
  - Neurofibroma
  - Hemangioma

SURGICAL CONSIDERATIONS

Role of Orthopedic Surgery

- Surgical intervention dependent on
  - Type of cancer
  - Bone/bones affected
  - Strength of bone/bones
  - Existing treatments
  - Symptoms
  - General health
- Role of orthopedic oncologist
  - Remove cancer in bones and/or muscles
  - Rebuild the resulting defects in a functionally acceptable manner

Goals of Surgery

- Curative
  - Main goal = remove ALL cancer
  - Remove tumor + normal surrounding tissue → clear margins
  - Cancer cells left behind = positive margins
  - Positive margins may need additional treatment
- Palliative
  - Relieve symptoms
  - Improve function
  - Quality of life
  - Not expected to cure primary disease
Surgical Interventions

- Complex decision making process
  - Limb salvage vs amputation
  - Reconstruction options
  - Limb lengthening procedures
  - Surgical management of metastatic disease

LIMB SALVAGE VS AMPUTATION

Limb Salvage vs Amputation

- Limb-salvage surgery (limb-sparing surgery) – achieving a successful wide excision while maintaining limb
  - May or may not require bone grafts, surgical fixation/stabilization (cement, intramedullary nails, screws, or rods), or soft tissue reconstruction
- Amputation – successful wide excision requires the partial or complete removal of a limb

Amputation

- Indications
  - Neglected tumor
  - Widespread or recurrent disease
  - Fracture
  - Considerable remaining growth in a young child
  - Superior function vs limb salvage procedure

Amputation

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete removal of tumor</td>
<td>Phantom sensation/pain</td>
</tr>
<tr>
<td>↓ local recurrence rate</td>
<td>↓ proprioception</td>
</tr>
<tr>
<td>Additional surgery often not needed</td>
<td>Painful neuromas in residual limb</td>
</tr>
<tr>
<td>Advances in prosthetics</td>
<td>Cosmesis</td>
</tr>
<tr>
<td>Management of cancer sequelae</td>
<td>Psychosocial aspects</td>
</tr>
</tbody>
</table>
Limb Salvage vs Amputation: The Pelvis

- Complex anatomy
  - Pelvic tumors difficult to remove completely with surgery alone
    - Often require chemotherapy and/or radiation
  - Pelvic reconstruction complicated and technically difficult
    - ↑ post-operative complications
- Limb salvage: internal hemipelvectomy
- Amputation: external hemipelvectomy

Internal Hemipelvectomy

- Limb-sparing surgery for tumors of the pelvis and its surrounding structures (also known as internal hemi-pelvic resection)
- Resection
  - Part or all of the unilateral pelvis
  - Proximal femur
  - Surrounding tissue if necessary
- Preservation
  - Neurovascular bundle
  - Lower extremity

Internal Hemipelvectomy

- Post-op considerations
  - WB status – WBAT, PWB, FFWB (foot-flat weight bearing)
  - Activity as tolerated
  - Leg length discrepancy
- Rehab implications and plan of care (POC)
  - ROM/therapeutic exercise
  - Bed mobility
  - Functional transfers
  - Balance
  - Gait training
  - ADL modifications
  - Adaptive equipment, assistive devices, DME
  - Orthotics

External Hemipelvectomy

- Highest level of lower extremity amputation for tumors in/around the hip and pelvis and surrounding structures
- Resection
  - Entire unilateral pelvis with disarticulation at SI joint and pubic symphysis
  - Entire lower extremity

External Hemipelvectomy

- Post-op considerations
  - WB status
    - NWB surgical site
    - WBAT through remaining extremities
  - Activity determined by wound closure
    - Pressure-relieving mattress
    - No prolonged sitting
    - Phantom sensation/pain
    - Psychosocial considerations
- Rehab implications and plan of care (POC)
  - ROM/therapeutic exercise
  - Bed mobility
  - Functional transfers
    - Cushioning for comfort and OOB tolerance
  - Balance
  - Gait training
  - ADL modifications
  - Adaptive equipment, assistive devices, DME
  - Orthotics

Literature Review

  - Descriptive retrospective cohort study
  - Compared functional outcomes and QOL of patients following internal vs external hemipelvectomy
  - Functional outcomes using the Barthel Index and QOL using the Linear Analog Self-Assessment tool (LASA)
    - Overall no significant difference in functional abilities between groups at 3 different time points
    - LASA subcategories showed no difference between groups, except in pain category
Literature Review

  - Retrospective study comparing post-op rehabilitation, functional outcome, and pain management following internal vs external hemipelvectomy
    - Inpatient rehabilitation admission associated with older age, plastic surgery involvement, and post-op complications
    - Significant FIM increases from initial evaluation to discharge in both groups
    - Patients s/p external hemipelvectomy required ↑ pain medication and ↑ hospital LOS

Case Study

Reconstruction

- Developments in adjuvant therapies and microsurgical technique
  - Limb salvage procedures > amputation
    - Wide local excision + complex reconstruction + adjuvant therapies = first-line approach
    - Plastic surgery for reconstruction and to enhance wound healing

RECONSTRUCTION

Reconstruction

- Skin graft – transfer of skin from donor site to recipient site (without blood supply)
  - Split thickness skin graft (STSG)
    - Portion of donor site skin including epidermis and some underlying dermis
  - Full thickness skin graft (FTSG)
    - Entire layer of donor site skin

Reconstruction

- Flap – transfer of skin, underlying tissue, and blood supply from donor site to recipient site
  - Includes skin, muscle, musculocutaneous, and osteocutaneous flaps
    - Pedicled flap – vascular supply remains connected anatomically throughout flap transfer
    - Free flap – vascular supply disconnected from axial blood supply during transfer, then reconnected microsurgically to new artery or vein at recipient site
Reconstruction \(^6,7\)

- Potential graft/flap complications
  - Infection/abscess
  - Wound dehiscence
  - Seroma/hematoma
  - Failure
    - Necrosis due to vascular compromise

Reconstruction

- Post-op considerations
  - WB status, ROM and/or activity restrictions
    - Orthopedic team: bone integrity and stability
    - Plastic surgery team: graft/flap integrity and healing
  - More conservative precaution/restriction followed
  - Meticulous review of orders, frequent communication, thorough documentation

- Rehab implications and plan of care (POC)
  - ROM/therapeutic exercise
  - Bed mobility
  - Functional transfers
  - Balance
  - Gait training
  - ADL modifications
  - Adaptive equipment, assistive devices, DME
  - Orthotics

Literature Review

  - Retrospective cohort analysis
  - Impact of well-integrated team performing complex, orthopedic reconstruction on outcomes of sarcoma resection
    - Amputation rate ↓'d significantly without ↑'d rate of positive margins
    - Post-op infection and wound dehiscence rates ↓’d

Case Study

Limb Lengthening \(^8\)

- Indications
  - Potential limb length discrepancy (LLD)
  - Need for durable reconstruction
  - Continued bone growth
  - Common tumor location near bone physes
  - Smaller skeletal size

LIMB LENGTHENING
Options for Lengthening

- Distraction osteogenesis (external fixation)
- Expandable prosthesis (internal lengthening)

External Fixation

- Utilizes the process of distraction osteogenesis to provide reconstruction of bone defects following tumor resection
  - Two segments of bone slowly pulled apart allowing new bone to grow and fill in gap
- Allows for continued growth over time
- Prevents significant leg length discrepancy

External Fixation

- Components
  - Rings: structural frame
  - Rods: connect rings
  - Pins/screws: inserted into the bone
  - Clamps: connect rods to pins

External Fixation

- Indications
  - Optimal function
  - Prevention of significant LLD
  - Maintain potential for continued limb growth
  - Satisfactory cosmesis

External Fixation

- Procedure
  - Wide resection of tumor
  - Placement of external fixator
  - Corticotomy of proximal and distal metaphysis of bone defect
  - Distraction followed by consolidation period
  - Surgical adjustments as needed
  - Removal of external fixator once adequate consolidation is achieved

External Fixation

- Possible complications
  - Pain
  - Pin site infection
  - ROM limitations
  - Fracture
  - Non-union
  - Neurovascular injury
  - Edema/cellulitis
  - Deep vein thrombosis (DVT)
**External Fixation**

- Post op considerations
  - WB status
  - ROM restrictions/goals
    - CPM
    - Foot plates
  - Infection risk
  - Handling
  - Anxiety/fear
- Rehab implications and plan of care (POC)
  - ROM/therapeutic exercise
  - Bed mobility
  - Functional transfers
  - Balance
  - Gait training
  - ADL modifications
  - Adaptive equipment, assistive devices, DME
  - Orthotics/shoe lift

**Expandable Prostheses**

- Option for internal reconstruction and lengthening during limb salvage procedures for continued growth
- Prevents significant leg length discrepancies
- Requires close follow up for periodic lengthening
- Prosthetic replacement may be necessary after maximal lengthening

**History of Expandable Prostheses**

1. **1st Generation**
   - Invasive, required open procedures
   - Worm drive, screw extension mechanisms
2. **2nd Generation**
   - Minimally invasive
   - Elongating screw, telescopic mechanism
3. **3rd Generation**
   - Non-invasive
   - Spring expansion, electromagnetic field

**Expandable Prostheses**

- Minimally invasive
  - Composed of exchangeable parts
  - Lengthening percutaneously via screwdriver
  - Requires periodic surgeries for lengthening
  - Pro: Allows for continued limb growth
  - Con: Surgery is indicated for each lengthening, associated possible surgical complications
- Non-invasive
  - Composed of energy loaded spring
  - Lengthening via exposure to external electromagnetic energy
  - Does not require surgery for lengthening
  - Pros: Less expensive, safer lengthening technique
  - Cons: Potential hardware failure

**Expandable Prostheses**

- Indications
  - Optimal function
  - Prevention of significant LLD
  - Maintain potential for continued limb growth
  - Satisfactory cosmesis
- Procedure
  - Wide resection of tumor
  - Reconstruction with expandable prosthesis
  - Acute lengthening
  - Periodic lengthening
Expandable Prostheses $^{13, 14}$

- Possible complications
  - Infection
  - Neurovascular injury
  - Mechanical failure
    - Hardware loosening
    - Mechanical dysfunction of expansion mechanism
  - Joint stiffness
- Less likely to occur in less invasive types of expansion

Expandable Prostheses

- Post-op considerations
  - WB status
    - Partial weight bearing initially
  - Knee immobilizer (if applicable)
- Rehab implications and plan of care (POC)
  - ROM/therapeutic exercise
  - Bed mobility
  - Functional transfers
  - Balance
  - Gait training
  - ADL modifications
  - Adaptive equipment, assistive devices, DME
  - Orthotics

Literature Review

  - Found equal number of revisions required
  - Similar functional results between the two types of lengthening prostheses

Case Study

SURGICAL MANAGEMENT OF METASTATIC DISEASE

Metastatic Disease $^{16}$

- Cancer originates from primary site in the body and spreads elsewhere via the bloodstream or lymph vessels
  - Originates from primary site in the body and spreads to bone
  - Originates in bone and spreads elsewhere in the body
- Orthopedic surgery may be indicated to treat primary or metastatic disease
Metastatic Bone Disease

- Most common locations of bone mets
  - Spine
  - Pelvis
  - Femur
  - Humerus
  - Ribs
  - Skull

Spinal Procedures

- Indications
  - Tumor resection
  - Relieve pressure
  - Provide stabilization
- Procedures
  - Spinal decompression
  - Spinal stabilization
    - Rods, screws, plates, cages
    - Kyphoplasty/vertebroplasty

Spinal Procedures

- Post-op considerations
  - Spinal precautions
    - No Bending (flexion/extension of spine)
    - No Lifting > 5-10lbs.
    - No Twisting of spine
  - Neurological function
  - Brace/collars

Brain Metastases

- Indications
  - Biopsy and/or resection of brain tumor
- Procedure
  - Bone flap provides access to brain for tumor removal

Craniotomy

- Indications
  - Biopsy and/or resection of brain tumor
- Procedure
  - Bone flap provides access to brain for tumor removal
**Craniotomy**

- **Post-op considerations**
  - Craniotomy precautions
    - Maintain position of head above the heart
    - No lifting > 5-10lbs.
    - Avoid Valsalva maneuver
  - Monitor neurological exams closely
    - Re-assessment with each patient encounter

- **Rehab implications and plan of care**
  - ROM/therapeutic exercise
  - Bed mobility
  - Functional transfers
  - Balance
  - Gait training
  - ADL modifications
  - Adaptive equipment, assistive devices, DME

**Lung Metastases**

- **Indication**
  - Metastatic lung nodules

- **Procedure**
  - Incision in chest wall between ribs to access pleural space
  - Excision of lung metastases
  - Chest tube placement for drainage

**Thoracotomy**

- **Indication**
  - Metastatic lung nodules

- **Procedure**
  - Pulmonary hygiene
  - Recent orthopedic surgery
  - WB status
  - AD - new surgical incisions in chest wall

- **Post-op considerations**
  - Pulmonary hygiene
  - Recent orthopedic surgery
  - WB status
  - AD - new surgical incisions in chest wall

- **Rehab implications and plan of care**
  - ROM/therapeutic exercise
  - Bed mobility
  - Functional transfers
  - Balance
  - Gait training
  - ADL modifications
  - Adaptive equipment, assistive devices, DME
  - Chest PT

**Literature Review**

- Karplus, et al. “Should contralateral exploratory thoracotomy be advocated for children with osteosarcoma and early unilateral pulmonary metastases?”
  - Reviewed incidence of unilateral and bilateral pulmonary metastases along with recurrence rates
  - Found that exploratory thoracotomy did not improve survival rates

**Case Study**
Continuum of Care

- Immediate post-op plan of care
- Rehab following hospital discharge
- Long-term rehab considerations

Immediate Post-op Plan of Care

- Patient/family directives
- Prognosis
- Functional status/activity restrictions
- Psychosocial
- Cancer care/medical needs
- Insurance

Discharge Planning

- Once patients are medically stable, discharged to:
  - Acute rehabilitation
  - Sub-acute rehabilitation
  - Home
    - With services (RN, PT, OT)
    - Without services
  - Outpatient rehabilitation
  - Skilled nursing facility
  - Hospice

Rehab Following Hospital Discharge

- Oncology rehabilitation is rapidly growing, however still a small community
- These patients CAN and WILL be encountered in any setting! (These patients may come to you!)
  - Patients travel along rehab continuum of care

Rehab Following Hospital Discharge

- Need for increased knowledge!
  - Orthopedic restrictions and precautions
  - Basic medical and oncology history
  - Immediate treatment-related side effects
    - Surgery
    - Radiation
    - Chemotherapy
  - Current and future POC

- When in doubt... CLARIFY!
  - Surgical teams
  - Orthopedic team
  - Plastic surgery team
  - Medical oncology team
  - Acute care therapy team
Long-Term Rehab Considerations

• Advances in treatment → increased survivorship!
• Increased survivorship → NEED for rehabilitation services!
  – Progression of disease
  – Disease recurrence
  – Treatment side-effects
  – No evidence of disease (NED)
    • Co-morbidities
  – Secondary malignancy

Rehabilitation Plan of Care

• Individualized plan of care based on **BOTH**
  cancer care and rehabilitation needs
• Requires constant re-assessment, adaptability, and communication

Conclusion

• Patients with bone tumors often require orthopedic surgical interventions that may result in complex medical and rehabilitation needs.
• Therapists must be aware of and adhere to the unique precautions and restrictions required following these procedures.
• A multi-disciplinary and multi-factorial approach to rehabilitation plan of care is crucial.
• Well-informed rehabilitation professionals are vital in returning function and improving quality of life.

References

References