Disorders of the Spine: Part I

Disc Herniation, Spinal Cord Tumors

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Degenerative Disease and Disc Herniations

Management of Degeneration of the Cervical Spine

Degenerative Disease

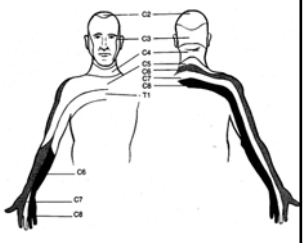
- Evaluation
- Imaging
- Treatment
  - Conservative
  - Operative

Evaluation

- Cervical Radiculopathy
  - Symptoms due to nerve root compression:
    - **Dermatomal pain**
    - **Numbness**
    - **Tingling**

Evaluation

- Dermatomes
  - Greek for "skin slice"
  - Area of overlying skin innervated by specific spinal nerve
  - Distinct motor and sensory findings pinpoint levels of injury



Evaluation

- Compression-Traction Test:
  - Both hands placed on the head
  - Downward pressure applied
  - Patient monitored for dermatomal pain or tingling
  - Followed by gentle traction to see if symptoms are alleviated

Evaluation

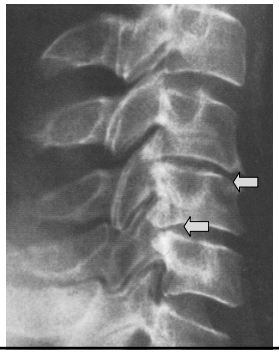
- Cervical Myelopathy:
  - Symptoms relate to loss of spinal cord function due to compression:
    - **Difficulty walking**
    - **Numb, clumsy hands**
    - **Loss of control of extremities**

Evaluation

- L'Hermittes sign: Pain radiating down arms and legs elicited by the forceful flexion on the cervical spine – "Lightning Bolt Shock"

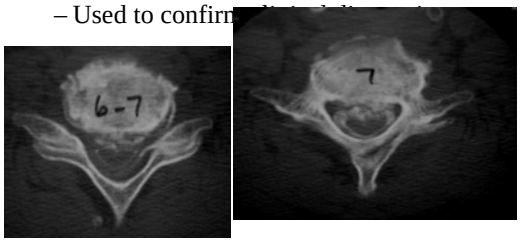
Imaging

- Plain films
  - Review alignment (kyphosis vs. lordosis)
  - May show disc space narrowing, osteophytes and instability



Imaging

- CAT SCAN
  - Used to confirm



Imaging

- MRI
  - Very sensitive
  - Can identify abnormalities in asymptomatic patients

Treatment

- Conservative
  - Soft collar
  - Traction
  - NSAID's
  - Physical therapy
- Operative

Treatment Principles

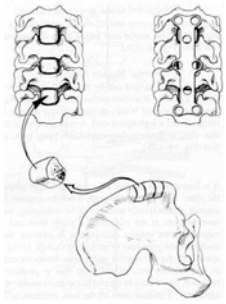
- Preservation of soft tissues
- Restore anatomic alignment
- Stable internal fixation
- Early pain free mobilization

Surgical Technique

- Discectomy
  - Smith Robinson Technique
  - Autograft v. Allograft

Caveat:

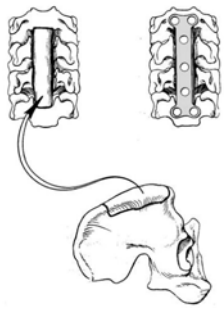
- The more levels, the greater chance of nonunion



Surgical Technique

- Corpectomy
  - Removal of one or more vertebral bodies
  - Broader decompression
  - Fewer interfaces

???? Graft



Management of Degeneration of the Lumbar Spine

Introduction

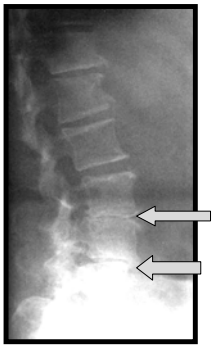
- Second most common reason for physician visits
- Low back pain affects 90 % of adults at some time in their life
- Annual treatment costs exceeds $23 billion

Introduction

- Most patients are over 40
- Occurrence:
  - Normal part of aging process
  - Varies with each patient
  - Certain factors accelerate process
    - **Vibration**
    - **Repetitive bending and lifting**
    - **Smoking**

Introduction

- Loss of normal structure
- Radiographic correlation with symptoms



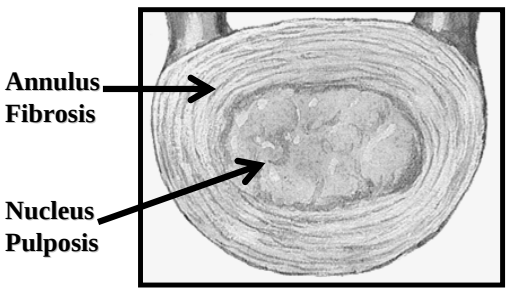
Introduction

- Degenerative conditions of the spine include:
  - Degenerative disc disease
  - Degenerative spondylolisthesis
  - Spinal stenosis

Degenerative Disc Disease

- Disc account for approximately 20-30% of the height of the spine

Intervertebral Discs

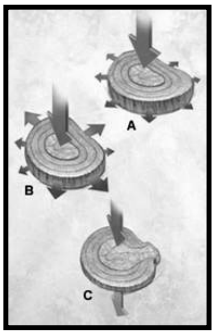


Degenerative Disc Disease

- Disc degeneration
  - Loss of disc height due to dehydration

Herniated Disc

- Annulus fibrosis tears and a portion of the nucleus pulposis leaks out

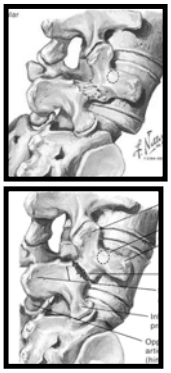


Spondylolisthesis

- Forward translation of one vertebral body with respect to another
- Most common in lower lumbar spine

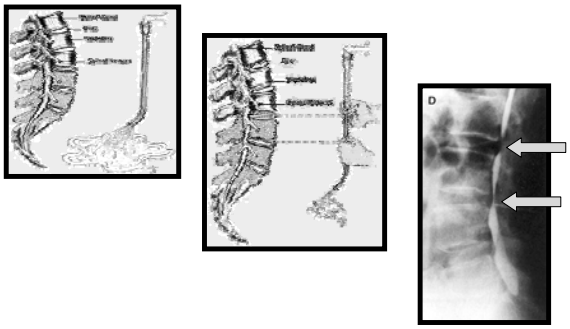
Listhesis vs. Lysis

- Spondylolisthesis
  - Anterior slippage of one vertebral body on another
- Spondylolysis
  - Defect of the pars interarticularis



Spinal Stenosis

- Narrowing of the spinal canal



Patient Assessment

- History
- Physical Examination
- Imaging
- Treatment

History

- Pain history
  - Exacerbates
  - Alleviates
- Numbness & tingling
- Weakness
- Bowel/bladder incontinence
- Medication history

Physical Examination

- Rule out other causes
  - Osteoarthritis of the hips
  - Vascular disease
  - Kidney disease
  - Spinal metastasis

Physical Examination

- Positive straight leg raise
- Weakness of foot/ankle muscles
- Decreased sensation calf/foot
- Diminished reflexes

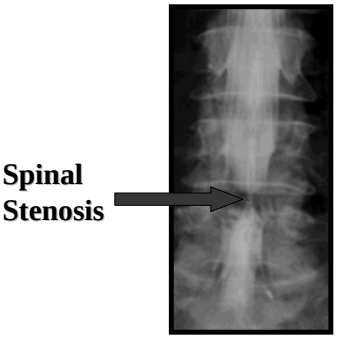
Imaging

- Plain x-rays
- MRI
  - Excellent for detecting degenerative disease affecting the discs
- Myelogram
- Discography
- All give information about the appearance of the spine but not necessarily the pathology

Plain X-Ray

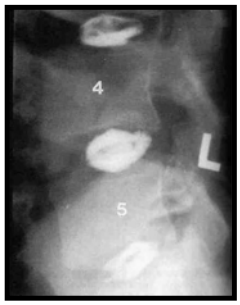
MRI

Myelogram



Discography

- Dye injected into disc
- Patient monitored for pain response
- Controversy:
  - Injection can cause pain in normal disc of asymptomatic patient



Treatment

- Conservative
  - Bed rest 2 to 3 days
  - Anti-inflammatory drugs
  - Analgesics for acute exacerbations
  - Antidepressants
  - Lumbosacral orthosis
  - Diet
  - Exercise

Treatment

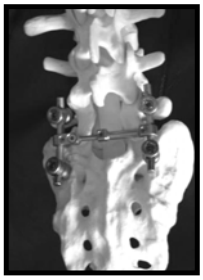
- Operative management
- Goals
  - Decompression of neural elements
  - Stabilization of unstable spinal levels
  - Correction of deformity

Operative Management

- Standard approach has been fusion
- Results have been inconsistent
- Only offered after non-operative methods have been thoroughly tried

Operative Management

- Implants: immobilize vertebrae while bony fusion is occurring



Surgical Management of Spinal Tumors

Classification of Spinal Tumors

- Primary tumors
  - Benign or malignant
  - More common in children
- Secondary tumors
  - Metastasize from other neoplasms
  - **All are malignant**
  - Skeletal system is 3rd most common site for metastatic lesions (following lungs and liver)
  - More common in adults

Classification of Spinal Tumors

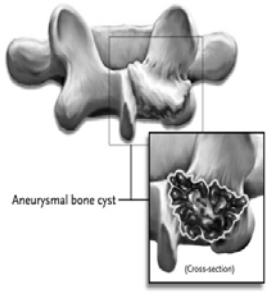
- Cervical, thoracic, lumbar, sacrum
- Location in vertebrae
  - Anterior; tend to be malignant
  - Posterior; more likely to be benign
- Cell of origin or differentiation
  - Microscopically identified
  - May impact method of treatment

Patient Presentation

- Most patients present to physician because of back pain
  - Not relieved by rest; often occurs at night
  - No difference in severity of pain from benign or malignant tumors

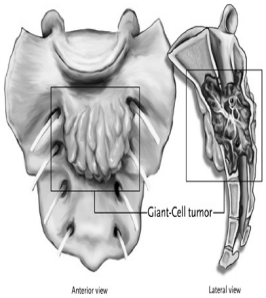
Primary Benign Tumors

- Aneurysmal Bone Cyst (ABC)
  - Not "true" tumors; evaluated and treated as such
  - Usually patients are teens or twenties
  - Occur most frequently in posterior elements
  - Slight predominance in females
  - Treatment of choice is embolization and surgical resection



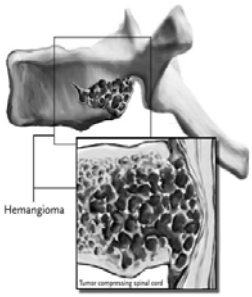
Primary Benign Tumors

- Giant Cell Tumor
  - Very aggressive
  - Primarily occurs in sacrum
  - Women have higher incidence than men
  - Most patients 30-40 years of age
  - May have associated bladder/bowel dysfunction
  - Treatment of choice is wide en-bloc resection; adjunctive radiation therapy



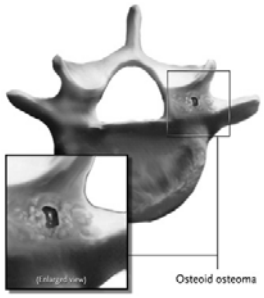
Primary Benign Tumors

- Hemangioma
  - Most are asymptomatic; found on incidental exam
  - Symptomatic lesions seen in patients 30-40 years old
  - Vertebral body generally affected
  - Frequently seen in thoracic spine
  - Risk of pathologic compression fracture, hematoma, expanding tissue mass, neurologic compromise
  - Treatment based on size, location, neuro involvement, patient age and health
  - Treatment of choice is complete excision



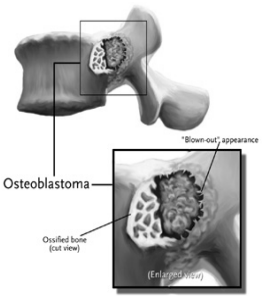
Primary Benign Tumors

- Osteoid Osteoma
  - Relatively common in the spine
  - Males 20-40
  - Posterior elements of lumbar spine: lamina or pedicle
  - Lesion size about 2cm
  - Scoliotic deformity may be present
  - Treatment of choice is complete surgical resection



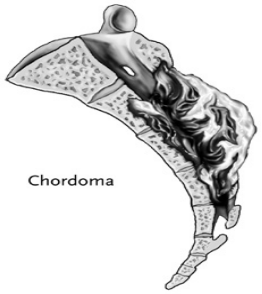
Primary Benign Tumors

- Osteoblastoma
  - Similar histologically to osteoid osteoma; more aggressive but not as common
  - Males 20-30 years old
  - Posterior elements lumbar spine
  - Lesion size <2cm
  - Potential to become malignant
  - Treatment of choice is total resection



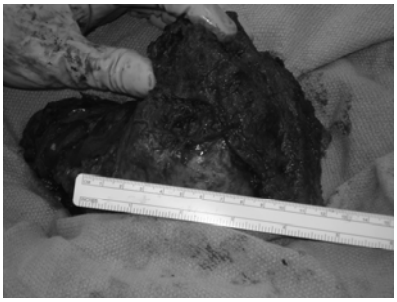
Primary Malignant Tumors

- Chordoma
  - Rare, slow-growing, slow to metastasize
  - Originate from cells of primitive nervous system
  - 2:1 male to female ratio
  - Patients 50-70 years of age
  - Half of all chordomas occur in sacrococcygeal region
  - Also found at base of skull bear foramen
  - Surgical treatment usually difficult due to location; excision if possible
  - Low patient survival rate



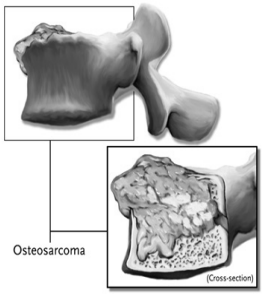
Sacral Chordoma

Sacral Chordoma



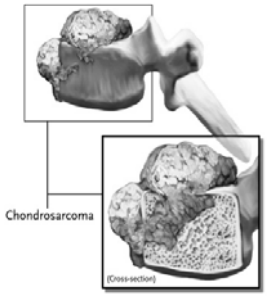
Primary Malignant Tumors

- Osteosarcoma
  - Rare, highly malignant
  - Affect younger population; increased frequency in males
  - Vertebral body most often affected; pedicles and posterior elements may also be involved
  - Treatment of choice is radical excision with chemotherapy/radiation
  - Generally poor prognosis due to metastases



Primary Malignant Tumors

- Chondrosarcoma
  - Rare; arise from cartilaginous tissue
  - Slow growing; patient may not present until tumor is well established
  - In spine, most common in thoracic, lumbar, sacrum
  - 2:1 male-to-female
  - Surgical treatment difficult due to location in spine; tend to be resistant to chemo and radiation
  - Overall poor prognosis

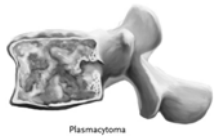


Primary Malignant Tumors

- Round Cell Tumors
- Group of malignant tumors classified by histological similarity
- Also called plasma cell tumors
- Highly malignant;occur frequently in spine

Primary Malignant Tumors

- Round Cell Tumors
- Plasmacytoma
  - 3:1 male-to-female; >50 years of age
  - Thoracic spine
  - Half of patients go on to develop multiple myeloma
  - Treatment of choice is radiation therapy
  - Surgery may be used for decompression/stabilization

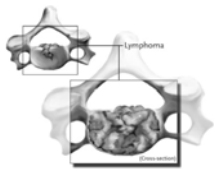


Primary Malignant Tumors

- Round Cell Tumors
- Multiple myeloma
  - Most common bone malignancy in adults
  - Most often found in the spine
  - Male-to-female ratio is equal; most patients 50-80 years of age
  - Other systemic organs may be involved; renal failure common
  - Surgery rare except to decompress and stabilize; treatment of choice is radiation/chemo because of multiplicity of tumors

Primary Malignant Tumors

- Round Cell Tumors
- Lymphoma
  - Usually non-Hodgkin's type
  - Most patients 40-60 years of age
  - Usually widely disseminated throughout the body
  - Anterior column most frequent spinal site
  - Respond to radiation and chemo; surgical decompression/stabilization may be indicated



Metastatic Tumors

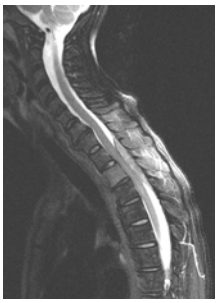
- 1 million new cancer diagnoses annually
- 2/3 cancer cases metastasize
- Primary tumors of lung, breast, prostate, thyroid, and kidney are most frequent neoplasm to spread to the spine
- Four theorized mechanisms for metastasis:
  - Direct erosion from near-by neoplasm
  - Arterial metastasis through nutrient arteries (lung tumors thought to spread through segmental arteries)
  - Venous distribution through azygous system (prostate and breast cancers)
  - Dissemination through lymphatic system; suspected but not clearly demonstrated

Metastatic Spine Tumors

- 1 million new cases of cancer annually
  - 70% develop metastatic disease
  - 40% develop **spinal metastases**
- Skeletal 3rd most common site for mets
  - Following lungs and liver

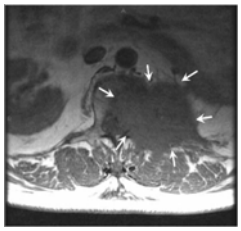
Neurosurgical Involvement

- 10-20% of spine metastases will develop spinal cord compression
- Location
  - Thoracic 70%
  - Lumbar 20%
  - Cervical 10%



You Will See These Patients!

- 95% of spine tumors are mets
- 10-30% of cancer patients will suffer from symptomatic spinal metastases
- Increased incidence due to improved life expectancy



Primary Pathology

- About 50% of spinal metastases
  - Breast, Lung, Prostate
- Other common primaries
  - Lymphoma, renal cell carcinoma, sarcoma, multiple myeloma, thyroid carcinoma
- 10% present with unknown primary
  - Half later found to arise from the lung

•Stark RJ, et al. Brain 105:189-213, 1982

Systematic Evaluation

Scoring System				Prognostic Score	Treatment Goal	Surgical Strategy
Point	Prognostic factors: Primary tumor	Visceral mets.*	Bone mets.**			
1	slow growth (breast, thyroid, etc.)		solitary or isolated	2 3	Long-term local control	Wide or Marginal excision
				4 5	Middle-term local control	Marginal or Intralesional excision
2	moderate growth (kidney, uterus, etc.)	treatable	multiple	6 7	Short-term palliation	Palliative surgery
4	rapid growth (lung, stomach, etc.)	un-treatable		8 9 10	Terminal care	Supportive care

* No visceral mets. = 0 point. ** Bone mets. including spinal mets.

Tomita K, et al: Spine 2001, 26:298-306

Classification Systems

Table 2. Revised Evaluation System for the Prognosis of Metastatic Spine Tumors

Characteristic	Score
General condition (performance status)	
Poor (PS 10%–40%)	0
Moderate (PS 50%–70%)	1
Good (PS 80%–100%)	2
No. of extraspinal bone metastases foci	
≥3	0
1–2	1
0	2
No. of metastases in the vertebral body	
≥3	0
2	1
1	2
Metastases to the major internal organs	
Unremovable	0
Removable	1
No metastases	2
Primary site of the cancer	
Lung, osteosarcoma, stomach, bladder, esophagus, pancreas	0
Liver, gallbladder, unidentified	1
Others	2
Kidney, uterus	3
Rectum	4
Thyroid, breast, prostate, carcinoid tumor	5
Palsy	
Complete (Frankel A, B)	0
Incomplete (Frankel C, D)	1
None (Frankel E)	2

Criteria of predicted prognosis: Total Score (TS) 0–8 — >6 mo; TS 9–11 — ≤6 mo; TS 12–15 — ≤1 yr.

Tokuhashi Y, et al. Spine 30(19):2186-91, 2005

Classification Systems

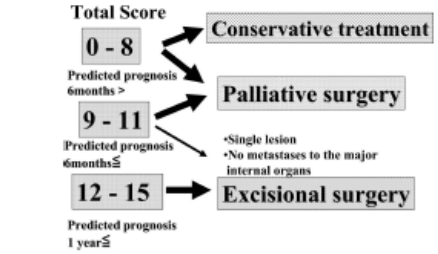


Figure 2. Strategy of treatment for spinal metastases.

Tokuhashi Y, et al. Spine 30(19):2186-91, 2005

Systematic Evaluation

- (N)eurology
- (O)ncology
- (M)echanical instability
- (S)ystemic disease

Bisky,: Hemat Oncol Clin North Am 2006 Dec;20(6):1307-17

Neurology

- Many patients now diagnosed before developing neurological deficits
- Earlier studies:
  - Muscle weakness (various degrees) - 75%
  - Sensory symptoms – 50%
  - Bladder and bowel dysfunction – 50%

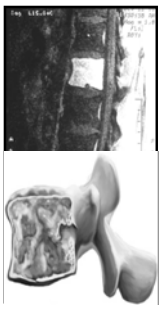
Byrne: NEJM:327:614-619, 1992

Pain Is Most Consistent Complaint

- > 95% present with back pain
  - Inflammatory mediators
  - Intraosseous hypertension
  - Mechanical instability
  - Neural compression

Intraosseous Hypertension

- Local (biologic)
  - Due to expansion of bone and periosteal stretching

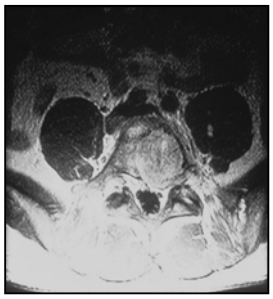


Mechanical Instability

- Pathological Fractures
  - Most common
  - Due to mechanical instability
  - Local tissue injury

Neural Compression

- Location
  - Central dura
  - Radicular
  - Dorsal root ganglion
- Etiology
  - Mechanical stretching
  - Ischemia
  - Inflammatory



Oncology

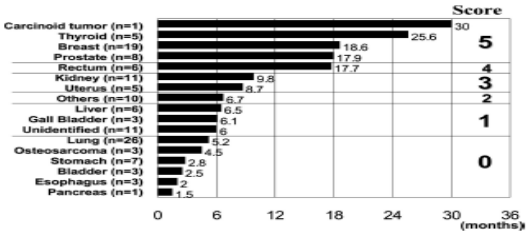


Figure 1. Association between the tumor origin and the average survival period after treatment until 1997. "Others" include primary lesions of colon (n = 2), ovary (n = 2), urethra (n = 2), melanoma (n = 1), germinoma (n = 1), liposarcoma (n = 1), and leiomyosarcoma (n = 1) in this series.

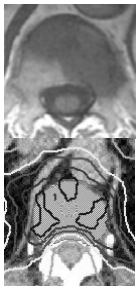
Tokuhashi Y, et al. Spine 30(19):2186-2191, 2005

Radiation/Chemo Sensitivity

- Very Sensitive
  - Lymphoma
  - Myeloma
  - Small Cell Lung
- Sensitive
  - Breast
  - Prostate
  - Thyroid
- Not Sensitive
  - Colon
  - Renal Cell
  - Melanoma
  - Sarcoma
  - Squamous/Adeno CA (Lung)

Spinal Radiosurgery

- Focus radiation to tumor & spare other structures
- Sparing spinal cord to deliver increased doses to tumor
  - Limited by cord tolerance
  - Allow for additional XRT after prior standard XRT
- Limited in cases where cord is compressed



Gerszten PC, et al. Neurosurgery 55(1):89-98, 2004
Bilsky MH, et al. Neurosurgery 54(4):823-830, 2004

SRS Delivery Methods

- "Shaped-beam" systems
  - Combine IMRT with advanced localization (coned-beam CT, frameless stereotaxis)
- Cyberknife
  - Linear accelerator mounted on robotic arm

Muacevic A, et al: J Neurosurg Spine 5:303-12, 2006

Historical Treatment

- Posterior Decompressive Laminectomy
  - 30% post treatment ambulation rate
- Radiation Alone
  - 47% post treatment ambulation rate
- Posterior Decompression and Radiation
  - 47% post treatment ambulation rate

Neuro Oncol 2005 Jan;7(1)64-76

Current Results

- Circumferential decompression superior to laminectomy alone
  - Ventral disease
  - Vertebral body 85%
  - Paravertebral region 10-15%
  - Subarachnoid/intramedullary space <5%

Neurosurg Clin N Am 15(2004)

Current Results

- Recent studies show better functional outcomes
  - ~90% improvement in pain
  - Ambulation
    - Maintained in 85%
    - Regained in 60%

Neurosurg Clin N Am 15(2004)

Metastatic Epidural SCC

- Patchell et al. Lancet 2005;366,643-48
  - Randomized, multi-center, non-blinded trial
  - Spinal cord compression from metastatic cancer
    - Radiation alone
    - Surgical decompression followed by radiation

Direct decompressive surgical resection in the treatment of spinal cord compression caused by metastatic cancer: a randomised trial

Roy A Patchell, Phillip A Tibbs, William F Regine, Richard Payne, Stephen Saris, Richard J Kryscio, Mohammad Mohiuddin, Byron Young

Summary

Background The standard treatment for spinal cord compression caused by metastatic cancer is corticosteroids and radiotherapy. The role of surgery has not been established. We assessed the efficacy of direct decompressive surgery.

Methods In this randomised, multi-institutional, non-blinded trial, we randomly assigned patients with spinal cord

Study stopped after interim analysis showed superiority of surgical treatment

Between Sept 1, 1992, and Dec 31, 2002, 123 patients were assessed for eligibility and, of these, 101 were entered into the trial before it closed (figure 1). Protocol violations occurred with five patients. In the surgery group, three patients did not receive postoperative

two-sided test, was 82%.[21] The study design also included provision for an interim analysis to be done at the halfway point (after 100 patients were entered into the trial) according to the O'Brien-Fleming rule.[22]

Patchell RA et al. Lancet 2005; 366:643-48

	Radiation group (n=51) median	Surgery group (n=50) median	Relative risk*	95% CI*	P*
Maintenance of continence	17 days	156 days	0·47	0·25–0·87	0·016
Maintenance of ASIA score	72 days	566 days	0·28	0·13–0·61	0·001
Maintenance of Frankel score	72 days	566 days	0·24	0·11–0·54	0·0006
Survival time	100 days	126 days	0·60	0·38–0·96	0·033

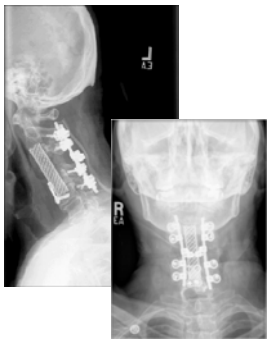
Patchell RA et al. Lancet 2005; 366:643-48

Cervical Metastatic Disease

- History
  - 88 y.o. female
  - Adenocarcinoma of rectum
  - Diagnosed in 8/97
  - Pulmonary mets 4/01
    - Irinotecan and 5-FU
- Presentation
  - Progressive neck pain in 9/02
  - Inability to raise arms above shoulders (to wash hair)
  - Inability to walk

Cervical Metastatic Disease

- Post-Op
  - D/C on post-op day #4/7
  - Neck pain resolved
  - Regained ambulation and arm strength (able to wash hair and raise arms)
- Radiation Therapy



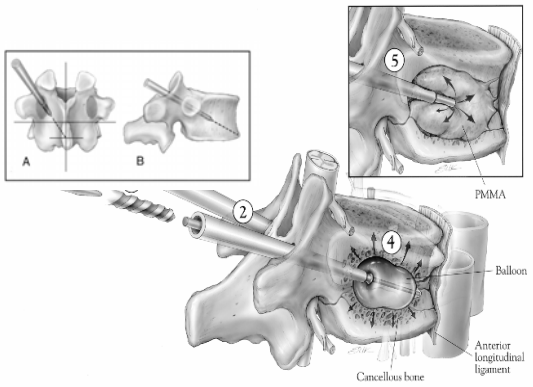
Surgery After XRT

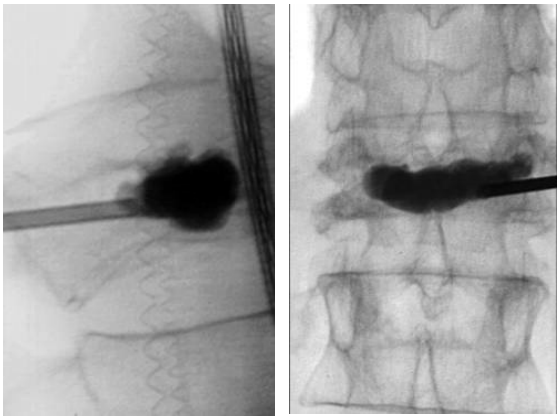
- High rate of wound complications in previously irradiated fields
  - McPhee IB, et al. Spine 1998, 23:726-733
  - Wise, JJ, et al. Spine 1999, 24:1943-1951
  - Ghogawala Z, et al. Spine 2001, 26:818-824
  - Fourney DR, et al. J Neurosurg 2001, 94 (1 Suppl):25-37

Vertebroplasty / Kyphoplasty

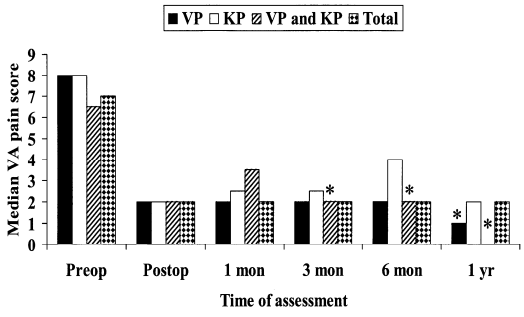
- Indications
  - Pain from pathologic compression fracture
    - Tumors with poor bone quality (MM)
  - Limited role
    - Neurologic compromise
    - Significant epidural disease
  - Combine with radiosurgery
    - Painful metastatic vertebral collapse

Hentschel SJ, et al. J Neurosurg Spine 2:436-440, 2005





Outcomes



Fourney, et al, J Neurosurgery, 2003

Operative Concepts

Surgical Goals

- Decompression
  - Neural-vascular decompression
  - Biopsy
  - Surgical "cure"
- Stabilization
  - Structural support
  - Anterior "column"
  - Posterior "tension band"

Surgical Factors

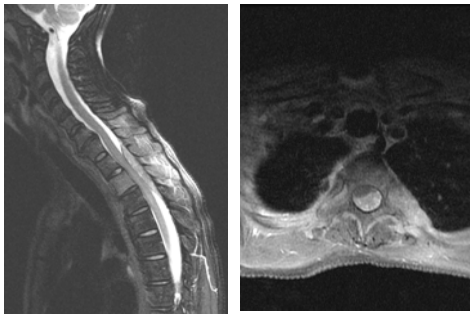
Tumor Factors

- Mass Effect
- Location
  - Deep vs. Superficial
  - Eloquent vs. Silent
- Size
- Vascularity
- Composition
  - Solid vs. Cystic
- Multiplicity

Patient Factors

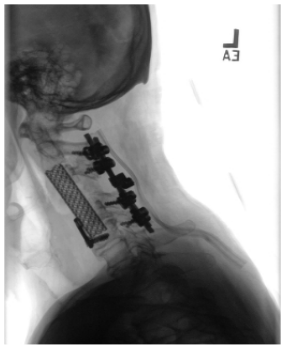
- Neurologic Status
  - Karnofsky Scale (100)
- Age
- Surgical Risks
- Anesthesia Risks
- Prior Therapy
- Patient and Family Desires/Fears
  - Quality vs. Quantity

Decompression Alone

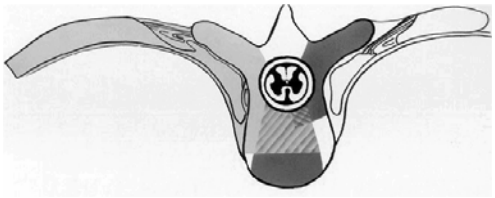


Cervical Approaches

- Anterior
  - Corpectomy
  - Discectomy
- Posterior
  - Laminectomy
- Lateral
  - Lateral Masses

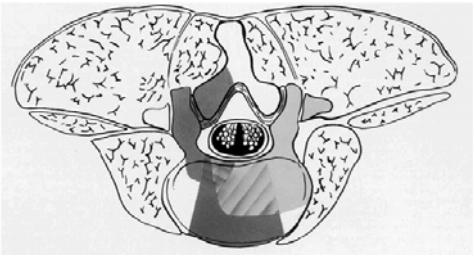


Thoracic Approaches



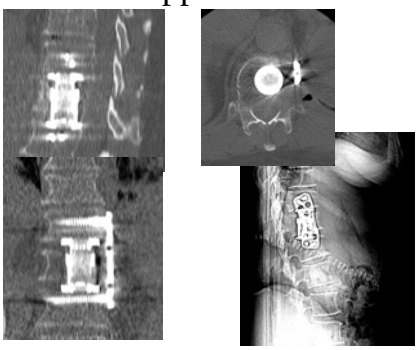
Brown: Costotransversectomy
Orange: Anterior transthoracic decompression
Yellow: Extracavitary approach

Lumbar Approaches

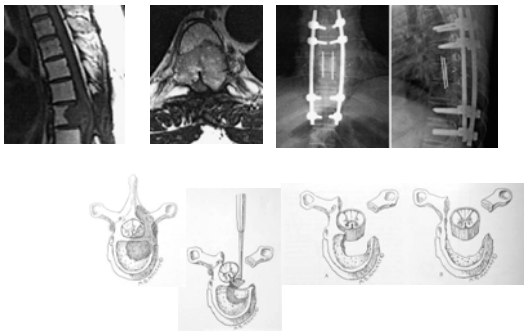


Brown: Laminectomy/transpedicular
Orange: Anterior transabdominal decompression
Yellow: Extracavitary approach

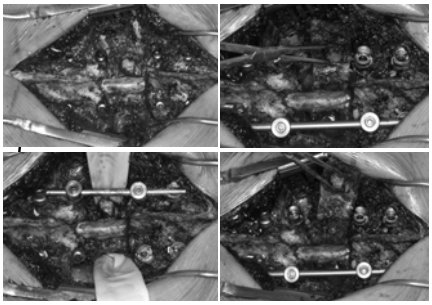
Anterior Approaches



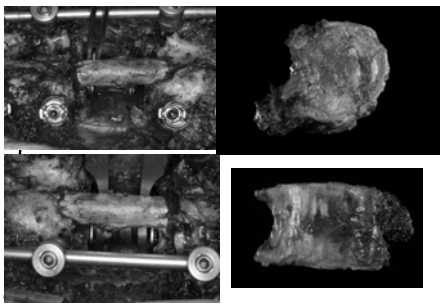
Single-Stage Posterior Surgery



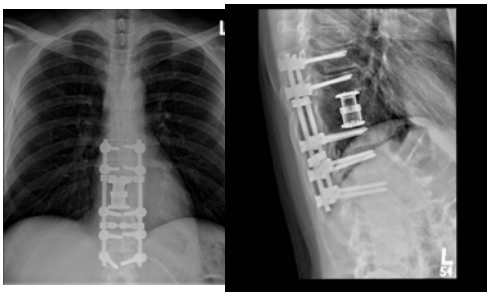
En-Bloc Resection



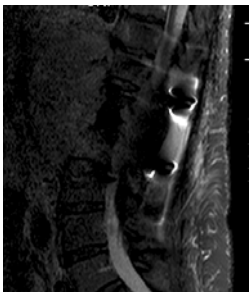
En-Bloc Resection

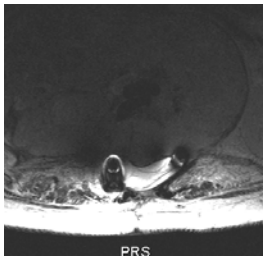


En-Bloc Resection

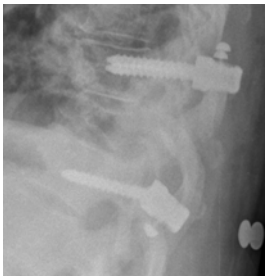


Post-Op Imaging Issues





Post-Op Imaging Issues



Questions?

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