Metastatic Spinal Disease
Review of recent review articles

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Metastatic spinal disease

- 18000 new cases per year in North America.
- 80% from lung, breast, GI, prostate, melanoma, lymphoma. “(BLT-PK)”
- Blastic: prostate, breast.
Primary tumor

- Lung: 14-31%.
- Breast: 16-24%.
- Prostate: 8-19%.
- Lymphoma: 6-12%.
- GI: 6-9%.
- Kidney: 1-9%.
- Unknown: 2-9%.
- Sarcoma: 2-8%.
- Thyroid: 6%.
- Melanoma: 2-4%.
- Others (MM, …): 13%.
Distribution

- 40 % of pt w/ cancer metastasize to bone.
- **Spine: most common osseous site for mets.**
- VB (70%) > arch (30%), post VB > ant VB
- Location:
  - vertebrae (85 %), mostly VB
  - paravertebral (15 %)
  - cord and meninges (5 %)
Distribution

All cancer patients

70% of all patients develop metastatic disease

40% of all patients develop metastatic spinal disease

10%-20% of these patients will develop epidural spinal cord compression (~25,000 cases/year)

Location:
Thoracic – 70%
Lumbar – 20%
Cervical – 10%
Presentation

- Pain: 95% initial symptoms, B/L in Tx, night pain.
- Pathological #.
- Hypercalcemia.
- Weakness: 75% by the time of Dx.
- Paraplegic: 15%
- C1-2: neck pain (agg w/ sitting)
- 15% w/ compression
- 6% Quadriplegic
- Onset to Dx = 2 m
Compression

- Spinal cord vs. conus medularis vs. cauda equina.
- Similar outcome.

<table>
<thead>
<tr>
<th></th>
<th><strong>Conus medularis</strong></th>
<th><strong>Cauda equina</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spont pain</td>
<td>Rare, B/L</td>
<td>Common, severe</td>
</tr>
<tr>
<td>Sensory loss</td>
<td>Saddle, B/L, diss</td>
<td>Saddle, U/L, B/L</td>
</tr>
<tr>
<td>Motor loss</td>
<td>Mild, sym, fascic</td>
<td>Marked, asym</td>
</tr>
<tr>
<td>Autonomic</td>
<td>early</td>
<td>late</td>
</tr>
<tr>
<td>DTR</td>
<td>S1</td>
<td>L3/4, S1</td>
</tr>
<tr>
<td>Onset</td>
<td>Sudden, B/L</td>
<td>Gradual, U/L</td>
</tr>
</tbody>
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History of management

♦ Radiation (XRT): assumed the primary treatment modality.

♦ Until 80s: only surgical option = decompression laminectomy:
  - no benefit to XRT (neurology, pain)
  - more infection & instability.
  - ineffective as VB is the location.

♦ 80s: ant decompression showed dramatic neurological recovery.
“New Era” in surgical management

♦ Goals:
  - To decompress the cord circumferentially (bone & tumor)
  - To resect tumor maximally to prevent local recurrence
  - To reconstruct & stabilize (not fuse)

♦ Approaches (depends on tumor location):
  - ant (transthoracic / retroperitoneal)
  - post (laminectomy, transpedicular, costo-transversectomy, lateral extracavitary)

♦ Improved neurological function compared w/ XRT.

♦ Despite the above, XRT continues to be the primary treatment in the newly diagnosed MSD in > 60 %.
Surgical approaches
Why bias toward XRT?

♦ XRT administered easily & quickly.

♦ Effectiveness of XRT repeatedly demonstrated.

♦ Surgical articles are level III evidences.

♦ Surgical articles are unknown to oncologist (the front-line).
## Surgery vs. Radiation / Indications

<table>
<thead>
<tr>
<th>Surgery</th>
<th>Radiation</th>
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</thead>
<tbody>
<tr>
<td>Radio-resistant:</td>
<td>Radio-sensitive:</td>
</tr>
<tr>
<td>- Sarcoma, lung, colon, renal</td>
<td>- Lymphoma, MM, small cell lung, seminoma, NB, Ewing’s</td>
</tr>
<tr>
<td>Spinal instability</td>
<td>Poor GMC</td>
</tr>
<tr>
<td>Bone induced compression</td>
<td>Minimal pain</td>
</tr>
<tr>
<td>Deformity induced pain/comp</td>
<td>Multilevel involvement.</td>
</tr>
<tr>
<td>Intractable pain</td>
<td>Minimal/isolated compression</td>
</tr>
<tr>
<td>Solitary site</td>
<td>Total neurological loss &gt; 48 h</td>
</tr>
<tr>
<td>Failed XRT</td>
<td>Life span &lt; 3-4 m.</td>
</tr>
<tr>
<td>Progressive compression</td>
<td></td>
</tr>
<tr>
<td>Unknown primary</td>
<td></td>
</tr>
<tr>
<td>Good life span</td>
<td></td>
</tr>
</tbody>
</table>
1. Current concepts in the management of metastatic spinal disease: The role of minimally-invasive approaches

Singh, Samartzis, Chicago.

- Metastatic lesions involve epidural space, paravertebral soft tissue and bone.
- Solitary vs. multiple.
- Pain, instability, fracture, neurological deficits.
- Complete paralysis w/o treatment.
Classifications: Modified Frankel (neurological function)

A. No function.
B. Intact sensation, no motor.

C. Some motor, Wheel Chait bound:
   a. no B/B
   b. neurogenic B/B
   c. intact B/B.

D. Symptomatic:  
   1. Walker. a. no B/B.
   2. Cane. b. neurogenic B/B.
   3. None. c. intact B/B.

E. Intact neurology
Classifications: Harrington (neurology & bone)

1. Intact neurology: **non-op.**

2. Involved bone, intact neurology: **nonop.**


4. Vertebral collapse induces pain: **OR.**

5. Vertebral collapse, **involved neurology**: **OR.**
Classifications: Tokuhashi (prognosis & life expectancy)

- 6 parameters: (Higher Score is Better Prognosis)
  1- general condition: poor=0, mod=1, good=2.
  2- # of extraspinal mets: >3=0, 1-2=1, 0=2.
  3- # of spinal mets: >3=0, 2=1, 1=2.
  4- major organs mets: irremovable=0, removable=1
                  no mets=2
  5- prime ca:      lung, stomach=0, K, liver, uterus=1,
                    T, P, B, rectum=2
  6- myelopathy:   complete=0, partial=1, none=2.
<table>
<thead>
<tr>
<th>Score</th>
<th>Survival</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 9</td>
<td>&gt; 12 m</td>
<td>Excision</td>
</tr>
<tr>
<td>6 – 8</td>
<td>3 – 12 m</td>
<td>?</td>
</tr>
<tr>
<td>&lt; 5</td>
<td>&lt; 3 m</td>
<td>palliative</td>
</tr>
</tbody>
</table>
Classifications: Tomita (1983)  
(prognosis & management)

1- grading: slow=1, mod=2, rapid=4
2- visceral mets: none=0, treatable=2, untreatable=4.
3- bone mets: solitary=1, multiple=2.

* Simple, prognostic & reliable

<table>
<thead>
<tr>
<th>2 – 3</th>
<th>W/M excision</th>
<th>Long-term control</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 – 5</td>
<td>M/IL excision</td>
<td>Medium-term control</td>
</tr>
<tr>
<td>6 – 7</td>
<td>Palliative op</td>
<td>Short-term palliation</td>
</tr>
<tr>
<td>8 - 10</td>
<td>Non-op</td>
<td>supportive</td>
</tr>
</tbody>
</table>
Morbidity / Timing for surgery

- RFs for complications in spinal mets: pre-op radiation, malnutrition, steroids.

- XRT then OR vs. OR then XRT in SCC:
  - more wound complications (32 % vs. 12)
  - Less mobility
  - Higher recurrence

- Short term mobility & continence
  - Higher in OR vs. XRT then OR.

- Surgery is effective in gradual neurological loss.

- Revision surgery has much higher complications.
Conventional external beam radiotherapy

- Initial treatment for most pt.
- Controls pain, decreases tumor size & inhibits its growth.
- Total dose of 2500 to 4000 cGy over 8-20 days.
- Normal tissue exposed to radiation.

- Patchell(2005): RCT, resection+XRT vs. XRT:
  - resection improved mobility, ability to work & sphincter.

- Ryken (2003): XRT as initial treatment for total paralysis, and radiosensitive tumors.
Stereotactic radiosurgery (SR)
Intensity-modulated radiotherapy (IMR)

- Focused beam radiation.
- SR: accurate targeting, frame based vs. image-guided (Novalis, CyberKnife).
- IMR: multiple beams w/ adjustable intensity so minimizes radiation to normal tissue.
  total dose of 800-1800 in 2 days.
- Effective in axial & radicular pain control, motor recovery.
- Small studies, function not yet studied.
- Experimental therapy, limited to poor surgical pt w/ recurrence and adjunct to surgery.
CyberKnife

A 52-year-old woman with a metastasis from a renal-cell carcinoma in L1. a) Isodoseline of the treatment plan are shown, representing a dose of 1200 cGy. Note the conformity, sparing both the spinal cord and the remaining left kidney (identified by the circle). b) A dose-volume histogram showing that 67% of the volume of the tumour received 80% of the maximum dose. The patient experienced considerable relief from pain within one month which lasted for more than eight months (reprinted with permission from Gerszten PC et al. CyberKnife frameless stereotactic radiosurgery for spinal lesions: clinical experience in 125 cases. Neurosurgery 2004;55:89-98).
Vertebroplasty / kyphoplasty

- Indication: hemangioma, compression #, MM, MSD.
- Complication d/t cement leakage is higher in MSD.

  - 84% marked pain relief.
  - leakage: 9% in vertebro, none in kypho.

- Gerszten (2005): kypho + radiosurgery in 26 pt w/path#:
  - 92% pain relief.
A 68-year-old man with disabling back pain, despite maximal spinal radiation therapy for metastatic hypernephroma infiltrating the T12, L1, L2, and L3 vertebrae. a) T1-weighted sagittal MRI showing almost complete replacement of the tumour within the four contiguous vertebrae. b) Axial CT scan of L1 showing complete osteolysis of the posterior vertebral cortex and almost complete replacement of the vertebral body by tumour. An 11-gauge needle is visible within the right posterior pedicle (arrow). c) Post-operative axial CT scan at L1 shows radioopaque cement contained within the vertebral body after percutaneous vertebroplasty (reprinted with permission from Barr JD. Percutaneous vertebroplasty for pain relief and spinal stabilisation. Spine 2000;25:923-8).
Paul Klimo, Meic Schmidt

♦ Outcomes:
  - ambulation (success rate & rescue rate)
  - pain control, sphincter function, survival local recurrence.
  - treatment complications.
♦ 24 surgical (84-02) & 4 radiotherapy (80-02) articles.
♦ Uncontrolled, nonrandomized cohort studies.
## Ambulatory grading scales

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>A no function</td>
<td>I walk w/o support</td>
<td>0 intact</td>
<td>I walk, mild weak</td>
</tr>
<tr>
<td>B sensation</td>
<td>II walk w/ support</td>
<td>1 Walk w/o support</td>
<td>II no walk</td>
</tr>
<tr>
<td>intact</td>
<td>III no walking</td>
<td>2 Walk w/ support</td>
<td>weak, move legs</td>
</tr>
<tr>
<td>C WC, some motor</td>
<td>IV paraplegia</td>
<td>3 Only stand</td>
<td>III severely weak</td>
</tr>
<tr>
<td>D ambulation w/symptom</td>
<td></td>
<td>4 Some mov’t</td>
<td>slight function</td>
</tr>
<tr>
<td>E neurology intact</td>
<td></td>
<td>5 No mov’t</td>
<td>IV no function</td>
</tr>
</tbody>
</table>

- Frankel 1969: A = no function, B = sensation intact, C = WC, some motor, D = ambulation w/symptom, E = neurology intact
- Tomita 1983: I = walk w/o support, II = walk w/ support, III = no walking, IV = paraplegia
- Cooper 1993: 0 = intact, 1 = Walk w/o support, 2 = Walk w/ support, 3 = Only stand, 4 = Some mov’t, 5 = No mov’t
- Brice & Mckissock 1965: I = walk, mild weak, II = no walk, weak, move legs, III = severely weak, slight function, IV = no function
Results

♦ Surgical:
  - 1000 pt, age=56, M=F, T > L > C.
  - Prime: B, K, L in 50 %.
  - some had previous XRT.
  - approach: ant 55 %, post 39 %, combo 6 %.

♦ Radiation:
  - 543 pt, age=63, M=F, T > L > C.
  - Prime: B, L, P in 70 %.
  - total dose of 2800-3200 cGy over 7-12 days.
Results

♦ Ambulation:
  - Success rate: 1.3 times greater in surgical.
  - Rescue rate: 2 times greater in surgical.

♦ Pain relief: 90% in surgical, 70% in radiation.
♦ Sphincter rescue rate: 66% in surgical, 26% in radiation.

♦ One-year survival: 41% in surgical, 24% in radiation.
  - Better: B & K, worse: L & S.
  - Poor if multiple sites, neurology deficit, extraspinal mets.

♦ Complication:
  - not in radiation, 23% in surgical (6% died).

- Simple laminectomy useless: tumors are anterior.
- **Ant** vs. post approach: better neurology & survival.

- Ant approach:
  - direct to lesion, bone saving, faster, ant column reconst,
    short segment fixation, improved wound healing.
  - not for poor GMC, circumferential tumors.

- Post or combined for circumferential tumors.
- Post approach: increased wound complications & CSF fistula.
Surgical management

♦ Goals:
  - control pain, improve neurological function & mobility.
  - provide stability, not fusion (life span!)
♦ Interbody struts: titanium cages rather than bone graft.
♦ Cement in struts.

Fig. 1. Drawing showing a No. 36 French chest tube placed into the vertebrectomy defect. Methylmethacrylate is then infused through a hole created in the middle.
Instrumentation / Region

- Ant: Short segment, one level above & below.
- Post: 3 or more levels above, 2 or more levels below.
- Combo: marked instability/ deformity, CT or TL junctions.
- Cx: ant (along SCM) or post (laminectomy).
Region

- CT junction: C7, T1,2
  1. ant (sternotomy or manubrial window) from left.
     - watch for RLN, TD, BCV.
  2. post if marked kyphosis.
Region

- **Tx:**
  1. ant: transthoracic or retropleural thoracotomy.
     - approach: right for T3,4, left for T5-10.
     - ant resection & ant instrumentation.
  2. post: ant resection, post instrumentation.
     - for poor GMC, and circumferential tumors.
     - B/L transpedicular resection, costotransversectomy, LECA.
Fig. 3. Drawing illustrating three posterior approaches. Upper: The transpedicular route allows resection of the VB from a true posterior approach. Center: Costotransversectomy allows a greater amount of VB to be resected compared with the transpedicular approach, and it provides an improved working angle. Right: The LECA allows complete access to the VB, and a much improved anterior working angle.
Region

- TL junction:
  1. post: LECA.
  2. ant: retroperitoneal extension of transthoracic/transpleural.
     - ant resection / post instrum
- Lx:
  - L1-4: ant (retroperitoneal).
  - L5: ant (transperitoneal).
     post (B/L transpedicular).
Approaches & results

♦ Ant:
  - optimal ant tumor resection & column stabilization.
  - 70-100 % improved motor.
  - 85-97 % improved pain.
  - 3 % wound complications (28 % in XRT+laminectomy).

♦ Post:
  - suboptimal ant tumor resection & graft placement.
  - increased wound complications.
  - marked pain relief, moderate neurological improvement.
  - CSF leakage.
Approaches & results

♦ Combined ant / post:
  - indications:
    3 column disease, marked instability / kyphosis,
    > one level, junctional disease, prior laminectomy.
  - staged.
  - improves ambulation & neurology.
  - increase morbidity & wound complications.
4. Surgical management of spinal metastases: analysis of prognostic factors during a 10-year experience
North, LaRocca, JHU, Baltimore.

- 61 pt w/ different primary tumors.
- Pain in 59, weakness in 53, bladder incontinence in 16.
- XRT prior to surgery in 13.
- Surgery: 16 Cx, 35 Tx, 24 Lx.
- Ant, post or combined surgery.

Results:
- Increased ambulation from 52 to 59.
- Post-op survival= 10 m.
### Prognostic factors

**Risk factors for poor outcome after an appropriate surgical intervention for spinal metastases**

<table>
<thead>
<tr>
<th>Status</th>
<th>Risk Factor</th>
</tr>
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<tbody>
<tr>
<td>ability to walk</td>
<td>primary tumor location other than breast inability to walk preop recurrence after primary radiotherapy op other than corpectomy</td>
</tr>
<tr>
<td>survival</td>
<td>primary tumor location other than breast recurrence after primary radiotherapy multilevel op cervical procedures</td>
</tr>
</tbody>
</table>
Prognostic factor scoring system

Simple prognostic factor scoring systems for ability to walk and for survival after an appropriate surgical intervention for spinal metastases

<table>
<thead>
<tr>
<th>Status/Risk Factor</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>ability to walk</td>
<td></td>
</tr>
<tr>
<td>breast cancer</td>
<td>very low probability of losing ability to walk</td>
</tr>
<tr>
<td>other tumor + 0 or 1 risk factors</td>
<td>72% likely to walk at 1.6 yrs</td>
</tr>
<tr>
<td>other tumor + 2 or 3 risk factors</td>
<td>50% likely to walk at 0.15–0.29 yrs</td>
</tr>
<tr>
<td>survival</td>
<td></td>
</tr>
<tr>
<td>breast cancer</td>
<td>50% survive at 1.7 yrs</td>
</tr>
<tr>
<td>other tumor, no other risk factor</td>
<td>50% survive at 0.73 yrs</td>
</tr>
<tr>
<td>other tumor, + ≥1 risk factor</td>
<td>50% survive at 0.36 yrs</td>
</tr>
</tbody>
</table>
5. Surgical resection in metastatic spinal cord compression
Patchell, The Lancet, Jan 2006

♦ RCT, multicenter, 10 y.
♦ Metastatic epidural spinal cord compression (MESCC)
♦ Circumferential decompression of cord + XRT vs. XRT.
♦ 200 pt selected but closed after 123 pt. d/t superiority of surgery.
♦ Ability to walk: 84% vs. 57%.
♦ Paraplegia rescue rate: 10/16 vs. 3/16.
♦ Decrease narcotic use & increase survival in surgery.
♦ Increase morbidity in XRT only.
Result / discussion

♦ Ant decom is an option for selected MESCC with: good medical status, life span > 3 m and single MESCC.

♦ Weakness:
  - pt allocation: 2 groups matched except for median time from Dx of primary to MESCC (7 m for XRT, 3 m for surgery).