ACCURAY

CASE STUDY

RECURRENT MULTIPLE MYELOMA AT CLIVUS & C1

UCSF Medical Center

UCSF CyberKnife® Team:

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CyberKnife Center:	University of California, San Francisco San Francisco, CA

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DEMOGRAPHICS

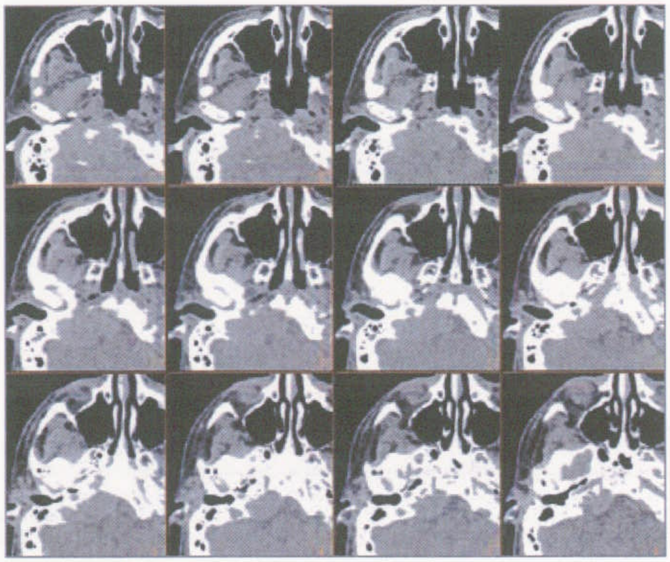
Sex:	Male
Age:	43 years
Histology:	Multiple Myeloma

CLINICAL HISTORY

Referred by:	Medical Oncology
Previous Treatment:	External beam radiation for initial disease. Chemotherapy, bone marrow transplant and repeat external beam radiation upon first recurrence. Thalidomide therapy and surgery two years later and bone marrow transplant the following year.

Case History

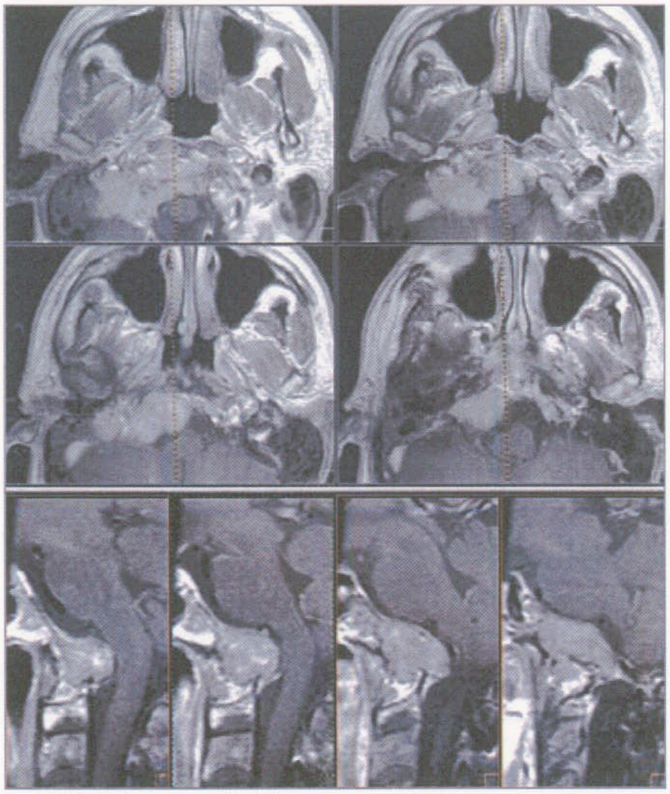
This 43-year-old male had an extended history of multiple myeloma. He was initially diagnosed when he presented with a severely destructive lesion at C1, which was treated with external beam radiation to the neck to 45 Gy. Two years later, he had recurrent disease, which was first treated with VAD (vincristine, adriamycin and dexamethasone). This was followed by a stem cell transplant preceeded by high-dose cyclophosphamide plus etoposide and high-dose melphalan. He then was retreated with external beam radiation to 36 Gy with the spinal cord blocked. His disease progressed, and two years later, he underwent a 3-phase surgical resection with occipito-cervical fusion with internal fixation. The next year, he underwent a bone marrow transplant. The patient had been stable for several months, when MRI showed increasing soft tissue mass involving the clivus and skull base, right greater than left.



Planning CT images (1.25 mm) showing the extent of disease in the axial plane covering 3 cm of cranial-caudal anatomy.

CyberKnife Treatment Rationale

This patient had been treated twice with radiation, chemo-therapy, stem cell transplant and surgery. Additional external beam radiation would have exceeded normal tissue tolerances. CyberKnife, with submillimeter[2] accuracy and highly conformal dosimetry, was the only reasonable option to control the patient's tumor without causing undue radiation-induced toxicity.[1,3]



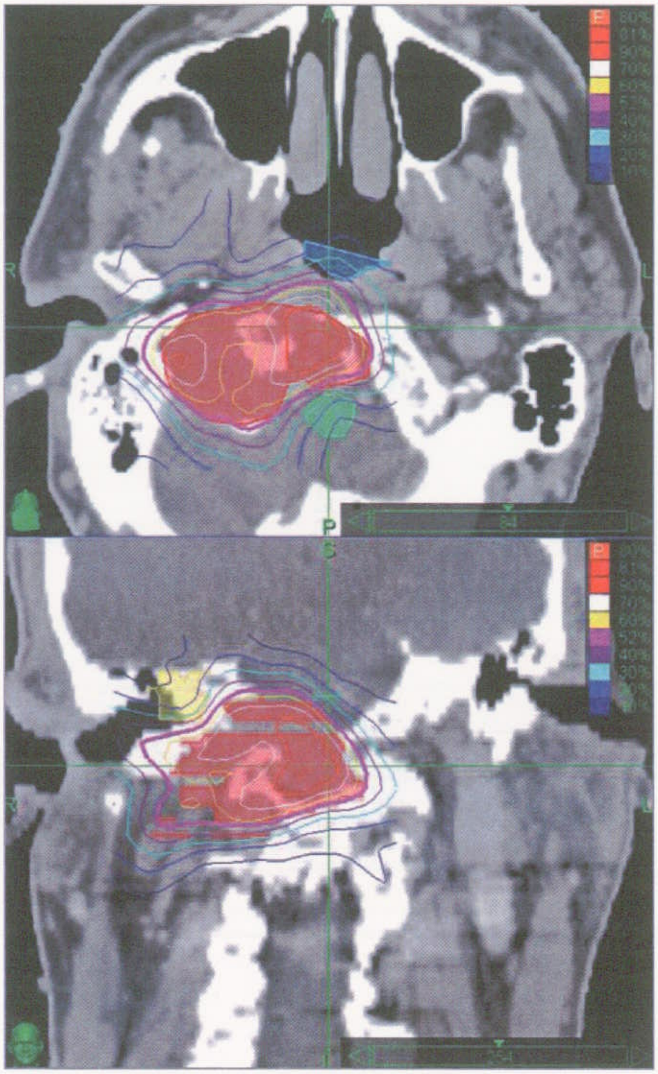
Axial and sagittal T1 MR with gadolinium contrast at the level of the clivus and C1 compressing the brainstem and upper cervical spine on the right side. This imaging study reveals a 4.8 x 2.9 x 2.8 cm mass extending to the right occipital condyle, the anterior arch of C1 and the superior body of C2, including the dens on the right side.

TREATMENT DETAILS

Tumor Volume:	29.14 cc	**Fractions / Treatment Time:**	5 @ 56 min per fraction
Imaging Technique(s):	CT, MRI	**Path Template:**	3 path 900_1000 mm
Rx Dose & Isodose:	30 Gy to 52%	**Tracking Method:**	Fiducial
Conformality Index:	1.30	**Collimator(s):**	15 mm
Tumor Coverage:	75.9%		
Number of Beams:	229		

Planning Process and Goals

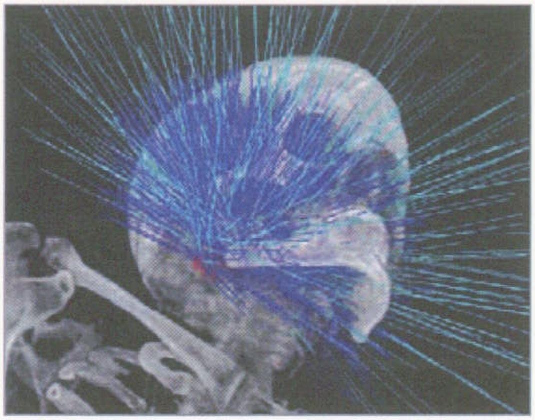
Fiducials were placed in the C2 spinous process, C3 spinous process, C5 lateral mass bilaterally, and the occiput. The patient was supported supine by a soft "timo-B" head rest and immobilized with a head-only Aquaplast mask. A contrast-enchanced CT scan was performed.



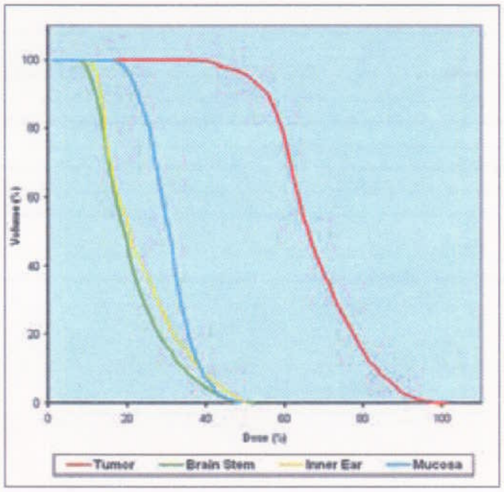
Axial and coronal planning images showing the delineated tumor volume (red) as well as the critical structures of brainstem (green), inner ear (yellow) and mucosa (blue).

Treatment Delivery

To accurately track and correct for patient movement during treatment, images were taken every other beam. Critical structure doses were designated as follows: a) maximum dose to brain stem/spinal cord was 26.54 Gy; 1 cc of brainstem/spinal cord received ≥ 15.0 Gy; 0.1 cc of brain stem/spinal cord received ≥ 21.75 Gy; b) maximum dose to the right inner ear was 23.20 Gy; 1 cc of inner ear received ≥ 7.9 Gy; 0.1 cc of inner ear received ≥ 16.1 Gy; c) maximum dose to the mucosa was 22.41 Gy; 1 cc of mucosa received ≥ 13.73 Gy; 0.1 cc of mucosa received ≥ 18.5 Gy.



Right inferior oblique 3D rendering of bony anatomy and CyberKnife beam positions.



Dose Volume Histogram (DVH) for all key structures.

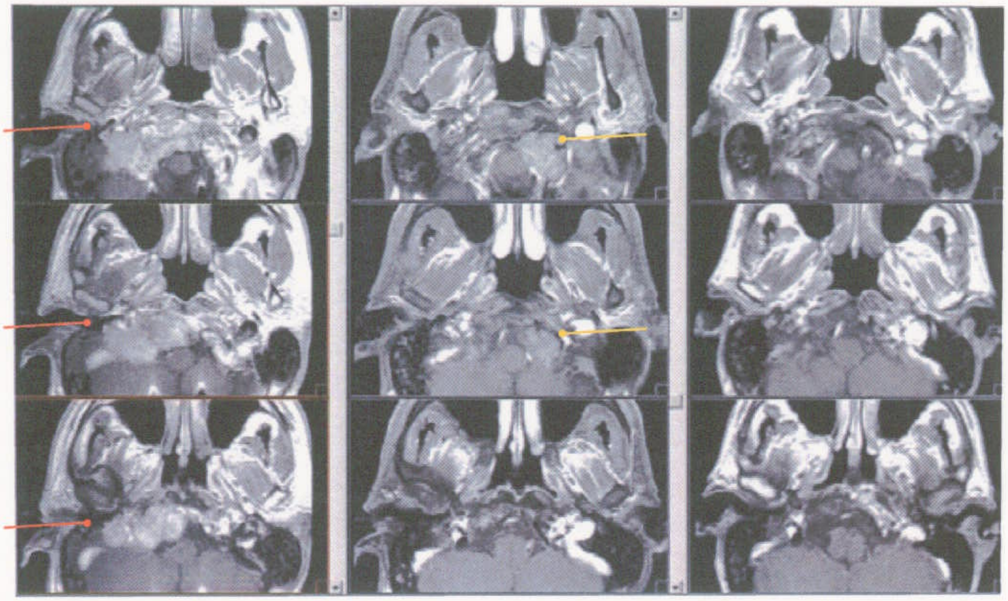
Outcome and Follow-Up

- The patient tolerated the treatment well with no adverse side effects
- The patient responded to CyberKnife treatment with a decrease in the size of his right cervical mass for the next 11 months
- Eleven months post-treatment, he developed a new mass in the sacrum, which was treated with conformal external beam radiation to 54 Gy with good clinical response
- Twenty months post-treatment an MRI of the neck revealed recurrent disease in the left neck, outside the volume previously treated with CyberKnife

  Disease extended from the left occipital condyle to the left C2 lamina with mild enhancement. He was treated with CyberKnife to the new lesion, receiving 20 Gy in 5 fractions prescribed to the 70% isodose line
- Follow-up MRI at 21 months showed a decrease in size of the mass. The patient continued to do well with occasional mild neck pain with no other neurological symptoms. At the 32-month follow-up, the patient showed stable disease

Conclusion and CyberKnife Advantages

- The CyberKnife System is useful for treating soft tissue lesions in the spine[1,3] that are inoperable or for which the maximum dose to the cord has already been given using standard radiation therapy approaches
- With high dose conformality the CyberKnife System has the ability to tightly target the tumor[2] with an ablative dose of radiation and a corresponding minimal dose to critical structures of spinal cord and brainstem



PreCK MR | *20 months PostCK1* | *32 months PostCK2*

Post-treatment CyberKnife images taken 20 (middle) and 32 (right) months after the pretreatment images (left) demonstrates complete regression of the right-sided mass (orange line) representing local control of the tumor. A left-sided recurrence (middle - yellow line) outside the treated volume, which was also treated by CyberKnife, subsequently shows a similar response 11 months later (right).

UNIVERSITY OF CALIFORNIA SAN FRANCISCO (www.ucsf.edu/radonc/cyber.html)
The University of California at San Francisco (UCSF) is one of the world's premier health science universities with over 18,000 faculty and staff. UCSF Medical Center ranks as one of the top ten hospitals in the US. Dr. David Larson is a world expert in radiation therapy and radiosurgery and is the director of the CyberKnife Center. Dr. Philip Weinstein is chief of the UCSF Neurospinal Disorders Program. CyberKnife radiosurgery began at UCSF in March 2003. The center's CyberKnife patient population has been 42% intracranial, 28% spine, and 27% other extracranial sites.

References

1. Ryu, SI, Chang SD, Kim DH et al, Image-guided hypo-fractionated stereotactic radiosurgery to spinal lesions. Neurosurgery 49(4):838-846, 2001.
2. Yu C, Main W, Taylor D et al, An anthropomorphic phantom study of the accuracy of CyberKnife spinal radiosurgery. Neurosurgery 55(5): 1138-1149, Nov 2004.
3. Gerszten PC and Welch WC, CyberKnife radiosurgery for metastatic spine tumors. Neurosurg Clin N Am 15(4):491-501, Oct 2004.

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