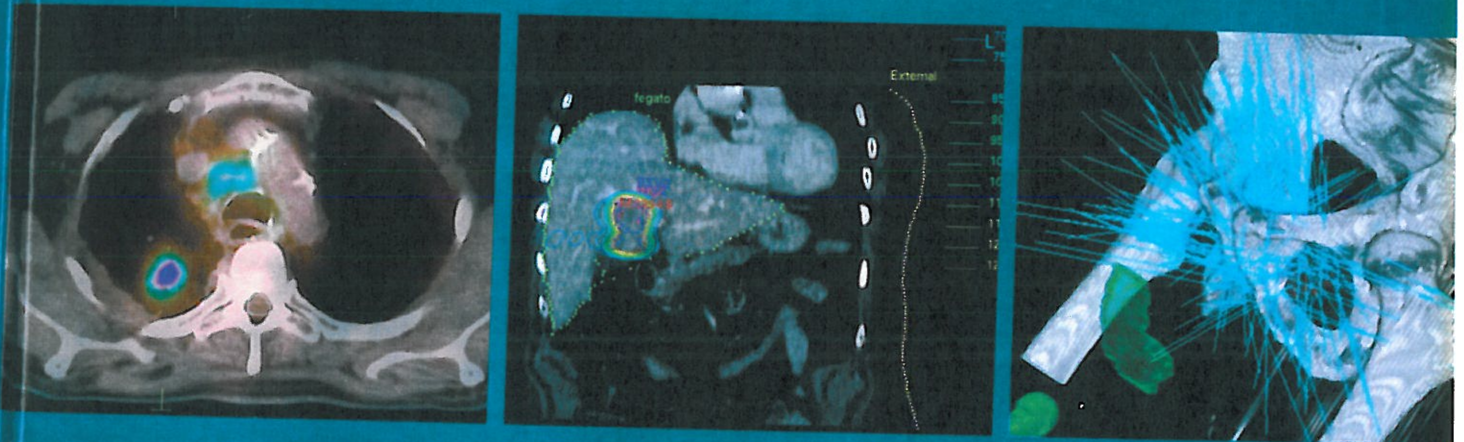
Image-Guided RADIATION THERAPY



A Clinical Perspective

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Image-Guided SRS in a Patient with Trigeminal Neuralgia Using the CyberKnife System

Case Study

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Patient History

A 60-year-old man presented with severe, lancinating right V2 trigeminal neuralgia pain that was gradually increasing in frequency and intensity over the past several years. The pain was coming in paroxysms or "clusters" with repeated episodes of a very intense and essentially debilitating pain, triggered by an intraoral stimulation, such as chewing, cutaneous stimulation with cold wind, or touching over the lateral side of the nose or malar region. He rated his pain at 5 to 6 on a 10-point visual analog scale and was taking high doses of gabapentin (4800 mg/daily) and carbamazepine (600 mg/daily), which tremendously interfered with his daily activities as he was severely fatigued.

Clinical and neurological examinations were normal, with light touch sensation preserved in all three trigeminus branches bilaterally. Magnetic resonance (MR) imaging of the brain showed no vascular loops or other local lesions in association with the right-sided trigeminal root entry zone.

In the past, the patient had undergone two radiofrequency neurolysis procedures with some improvement that only lasted 4 and 2 months each time, respectively. Our recommendation was for image-guided stereotactic radiosurgery using the CyberKnife system (Accuray Inc, Sunnyvale, CA).

Simulation

A week before the treatment, the patient underwent computed tomography (CT) simulation on a LightSpeed scanner (GE Healthcare, Waukesha, WI) after fabrication of a customized thermoplastic immobilization mask of the head. A contrast cisternography for precise visualization of the trigeminal nerve within the prepontine cistern was also performed and fused to the CT.

Treatment Planning

The trigeminal nerve was indentified on the CyberKnife planning workstation and a segment of the nerve was marked as the clinical target volume (CTV). A radiosurgery treatment plan was generated consisting of 123 beams collimated to 5 mm prescribing 60 Gy marginal dose (D_{max}, 70 Gy) to a 6-mm section of the nerve sparing 2 mm at the dorsal root entry zone and not extending into the gasserian ganglion within the Meckel's cave (Figure 15D-1). The treatment plan was generated through nonisocentric geometry using the 650 node set especially designed for trigeminal neuralgia cases. In the treatment planning process an artificial dose tuning structure was generated to additionally protect the brain stem.

Treatment Delivery

On the day of treatment, the patient was placed in the treatment position and his head was immobilized within his customized thermoplastic mask. Patient setup and target tracking were accomplished by comparing digitally reconstructed radiographs created from the planning CT data set with standard orthogonal cranial x-rays taken after every five beams throughout the treatment. Small patient movements were detected and new target coordinates sent to the robotic arm to adjust the aiming of the linear accelerator. These offsets were reduced to less than 1 mm in the treatment space and less than 1° of rotation

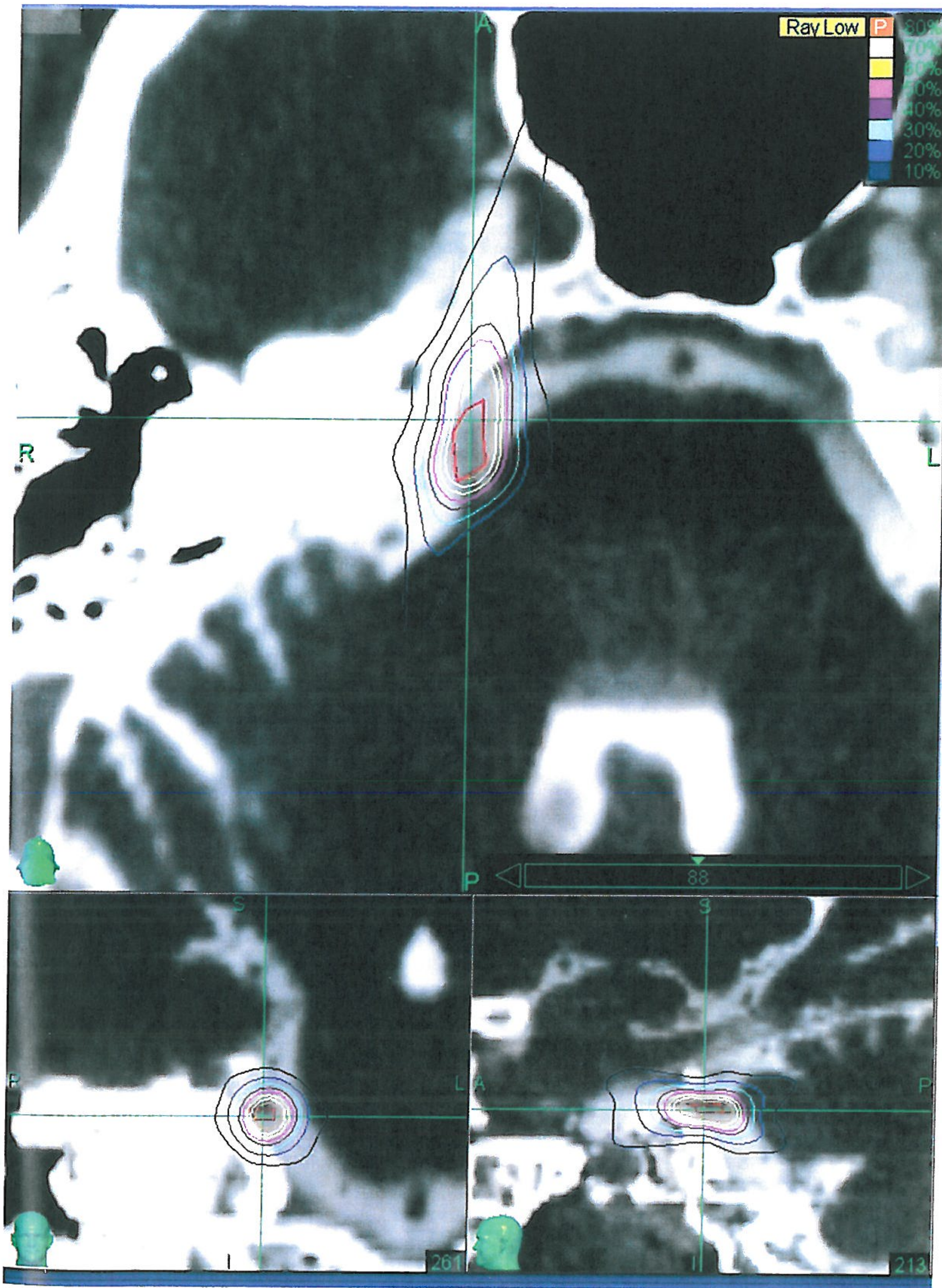

FIGURE 15D-1. Treatment plan: axial (top), coronal (left), and sagittal (right) views. A red line demonstrates the nerve segment contoured as target volume with a short segment near the root entry zone excluded from the target volume. Surrounding isodose lines represent 10% (dark-blue outermost line), 30% (light-blue line), 50% (magenta line), and 80% (orange line at the nerve margin) of the maximum nerve dose of 100%.

before initiation of treatment. The entire treatment took approximately 60 minutes.

Clinical Outcome

The patient tolerated the treatment well and had a substantial improvement of his pain within a few days. He noted minimal lancinating pain, substantial improvement in triggering factors, and no facial numbness at his 3-week follow-up. His pain relief was rated as moderate – 2 on the Boulder-Stanford pain relief scale (> 50% pain relief, and < 90% reduction in use of pain medications).[1] Medications were tapered to 600 mg/daily of gabapentin for the first 6 months after the treatment.

At the most recent follow-up (3 years and 8 months) pain relief was rated as excellent –1 (> 90% pain relief, completely off pain medications); however, the patient developed some mild, nonbothersome facial numbness.

Our preliminary multicenter experience treating trigeminal neuralgia with the CyberKnife system was published earlier.[1] Ninety-five patients were treated between May 2002 and October 2005. Sixty-five (67%) noted excellent pain relief, with a median time to pain relief of 14 days (range, 0.3–180 days). Overall, 45 (47%) experienced posttreatment numbness. The overall complication rate was 18%. At a mean follow-up of 2 years, 47 (50%) of patients were noted to have sustained pain relief and no longer required medications. Radiation dose and length of nerve treated were correlated with better pain relief.

Reference

1. Villavicencio AT, Lim M, Burneikiene S, et al. CyberKnife radiosurgery for trigeminal neuralgia treatment: a preliminary multicenter experience. *Neurosurgery.* 2008;62(3):647–655.