

# Democratizing Radiosurgery

John R. Adler, M.D.  
Stanford University



AANS'19



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## CONFLICTS OF INTEREST

- ZAP Surgical Systems
- Cureus Inc.
- Stanford University



Free Parking!!



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## CONFLICTS OF INTEREST

“If you have no conflicts,  
I have no interest”



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## What neurosurgeons can do for patients is driven by our tools




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## Radiosurgery: A Quiet Revolution

### A recommendation for training in stereotactic radiosurgery for CNS neurosurgery residents

J. David Cozzitelli, MD, Thomas C. Chen, MD, Andrew A. Berman, MD, and Robert M. Starke, MD, Department of Neurological Surgery, University of Pittsburgh Medical Center, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania; Department of Neurological Surgery, University of Michigan Medical Center, Ann Arbor, Michigan; Department of Neurological Surgery, University of California, San Francisco, California; and Department of Neurological Surgery, University of Washington School of Medicine, Seattle, Washington

The field of stereotactic radiosurgery (SRS) was established in June 1985 in the United States as an adjunct to neurosurgery. It has since become a well-established, well-recognized, and well-defined subspecialty. Initially, the focus of SRS was treatment of intracranial lesions. Over time, the procedure evolved and is now regarded as the SRS was widely adopted for benign and malignant intracranial lesions, including meningiomas, acoustic neuromas, and vestibular schwannomas. Since the mid-1990s, SRS has expanded its application to the management of both brain and spine lesions and extracranial lesions.

When the focus of stereotactic intervention was directed to benign lesions, SRS is part of an almost exclusive neurosurgical approach. These patients are of the intracranial head base and a more understanding of the anatomical and developmental relationships of the brain and spine are particularly important for high-quality results, even for these patients.

Before the development of stereotactic techniques, neurosurgeons treated patients with multiple brain lesions by craniotomy and craniotomy. In the early 1980s, the use of stereotactic techniques allowed for the treatment of multiple lesions with a single approach. This approach allowed for the treatment of multiple lesions with a single approach. This approach allowed for the treatment of multiple lesions with a single approach.

that are not included in the majority of most neurosurgical residencies. Neurosurgical training, however, is not an alternative neurosurgical training and that residents in other neurosurgical residencies have achieved significant proficiency. However, as noted above, additional training, including training and those achieved based on clinical experience by a resident and neurosurgeon, is not an alternative neurosurgical training and that residents in other neurosurgical residencies have achieved significant proficiency. However, as noted above, additional training, including training and those achieved based on clinical experience by a resident and neurosurgeon, is not an alternative neurosurgical training and that residents in other neurosurgical residencies have achieved significant proficiency.

In 2003 the number of CPT codes for radiosurgery (then 61793) that were submitted exceeded the number of codes submitted for craniotomy for tumor, not meningioma




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### Research

## Original Investigation Effect of Radiosurgery Alone vs Radiosurgery With Whole Brain Radiation Therapy on Cognitive Function in Patients With 1 to 3 Brain Metastases A Randomized Clinical Trial

Paul D. Brown, MD, Kurt Joachims, MD, Karlo V. Ballman, PhD, Elena Franco, PhD, Jonette Carter, PhD, S. Keith Anderson, MD, Norman W. Carnes, BS, Fred G. Barkas, MD, Richard Dering, MD, Stuart B. Burt, MD, Cynthia Haines, MD, Constantinos M. Vekris, MD, Stefan M. Stieber, MD, Bruce J. Petrek, MD, Euantha Galanis, MD, Jan C. Buckner, MD, Anthony L. Asher, MD

**IMPORTANCE** Whole brain radiotherapy (WBRT) significantly improves tumor control in the brain after stereotactic radiosurgery (SRS), yet because of its association with cognitive decline, its role in the treatment of patients with brain metastases remains controversial.

**OBJECTIVE** To determine whether there is less cognitive deterioration at 3 months after SRS alone vs SRS plus WBRT.

**DESIGN, SETTING, AND PARTICIPANTS** At 34 institutions in North America, patients with 1 to 3 brain metastases were randomized to receive SRS or SRS plus WBRT between February 2002 and December 2013.

**INTERVENTIONS** The WBRT dose schedule was 30 Gy in 12 fractions; the SRS dose was 18 to 22 Gy in the SRS plus WBRT group and 20 to 24 Gy for SRS alone.

**MAIN RESULTS AND MEASUREMENTS** The primary end point was cognitive deterioration (defined as  $\geq 10$  from baseline on at least 1 cognitive test at 3 months) in participants who completed the

Additional page 393  
Supplemental content at [jama.com](http://jama.com)




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THAT WAS THEN. **THIS IS NEXT.**  
A New Day Dawns....

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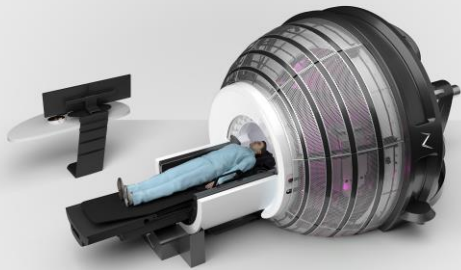
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### ZAP-X GYROSCOPIC RADIOSURGERY



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### SELF-SHIELDED

- No shielded treatment vault
  - Operating under full clinical workload with 1m safety perimeter
  - Resulting in <1.0 mSv dose/year
- Enables simpler point of care where the patients are:
  - Department expansions
  - Satellite facilities
  - Physician offices
  - ASCs



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## LINAC-BASED

- Optimized for cranial radiosurgery, with steep dose gradient
  - 3MV S-Band linear accelerator
  - 1500 MU/minute
  - 45 cm SAD
  - 260+ non-coplanar beam angles
- No compromises of brain SRS for general RT



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## Optimized Collimation

- Multiple circular apertures
- Collimator leaks <math><0.01\%</math> of the primary radiation beam
- In comparison, multi-purpose radiotherapy MLC leakage ~.5%



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## SAFETY INNOVATION

- Real-time dose validation
  - Consumable MV dosimeter independently audits expected exit dose in real-time
  - Mitigates potential risk of mechanical or human error



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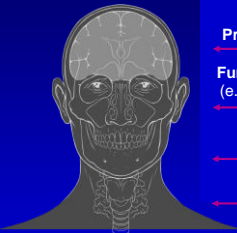
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## APPLICATIONS



Primary & metastatic brain tumors

Functional & vascular disease  
(e.g. trigeminal neuralgia, AVM)

Head & neck lesions

Cervical spine lesions



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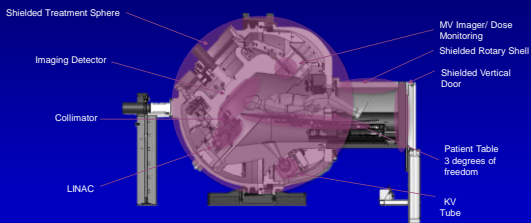
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## ZAP-X GYROSCOPIC RADIOSURGERY



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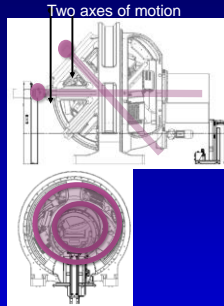
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## EXOSKELETON

- 3D gyroscopic gantry mobility
  - Two axes of motion give > solid angle coverage
- 83 cm bore diameter
  - Similar to large bore CT or CT-Sim
  - 1.4X larger than standard MRI (60 cm)
- 165 cm treatment sphere interior



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## IMAGE GUIDANCE

- Integrated KV imaging system provides real time tracking
- Intra-fraction image guidance & auto-alignment throughout SRS
- User-defined frequency



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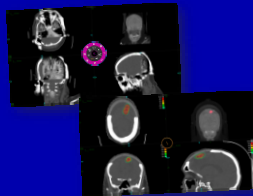
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## TREATMENT PLANNING

- Image types
  - Primary: CT
  - Secondary: MRI, PET CT, additional CT
- Isocentric planning & delivery
  - Forward
  - Inverse
- First gen system already allows for satisfactory conformity with complex target shapes



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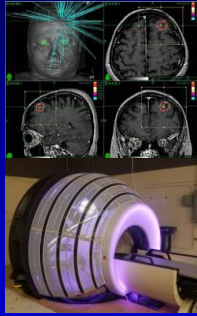
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## Radiomodulation

- Radiosurgery at non-lesioning doses
- Specific nodes (gray matter) or connections (white matter) within a brain circuit are targeted
- Hypothesized to focally reduce metabolic activity
- Circuit up-regulation or down-regulation
- Potential to be a major advance in the treatment of psychiatric illnesses




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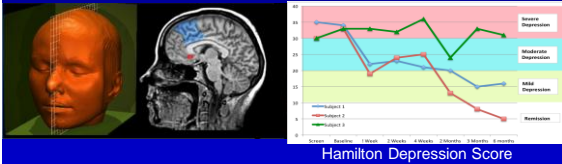
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## Cg25 Irradiation for Intractable Bipolar Disorder

John R. Adler, Jr., Scott Soltys, Brent Solvason  
Stanford

60 Gy to bilateral subgenual cingulate: Significant decline in depression scores in 2/3 patients, sustained at 1 year




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## The Future of Neurosurgery?



Year 2264

Precision Directed Energy?




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## Who said?

"I would like to see the day when somebody would be appointed surgeon somewhere who had **no hands**, for the operative part is the least part of the work."



Harvey Cushing



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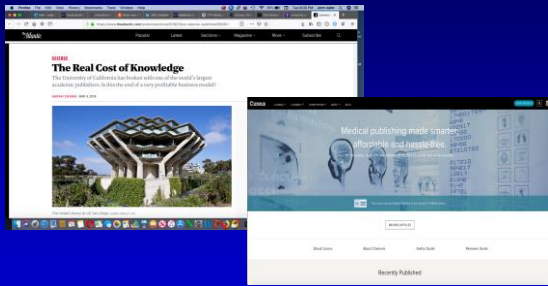
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## Cureus



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