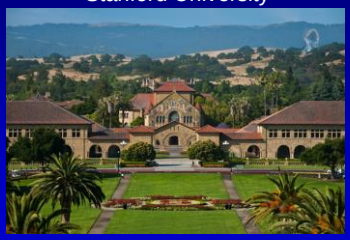
Democratizing Radiosurgery

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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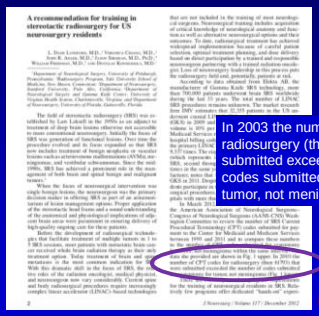
Radiosurgery: A Quiet Revolution



A recommendation for training in stereotactic radiosurgery for US neurosurgery residents

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 Jaeckle, MD; Karla V. Ballman, PhD; Elana Farace, PhD; Jane H. Cerhan, PhD; S. Keith Anderson, MS; Xiomara W. Carrero, BS; Fred G. Barker II, MD; Richard Deming, MD; Stuart H. Burri, MD; Cynthia Menard, MD; Caroline Chung, MD; Volker W. Stieber, MD; Bruce E. Pollock, MD; Evanthia Galanis, MD; Jan C. Buckner, MD; Anthony L. Asher, MD

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TWO MILLION

- Two million brain tumor patients worldwide are potential candidates for stereotactic radiosurgery
- Yet only 150,000 receive such treatment
- Costs and complexity of legacy technologies push radiosurgery out of reach for too many

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Radiosurgery: Problems & Opportunities

- Very expensive technology: $5M+
- Requires complex & costly hospital facility
- Most SRS facilities based on multi-purpose RT linacs
  - Devices cross multiple surgical specialties
  - More Flexibility = MORE complexity
- Complex radiosurgical devices require considerable training
- Out of reach for >90% of the world population

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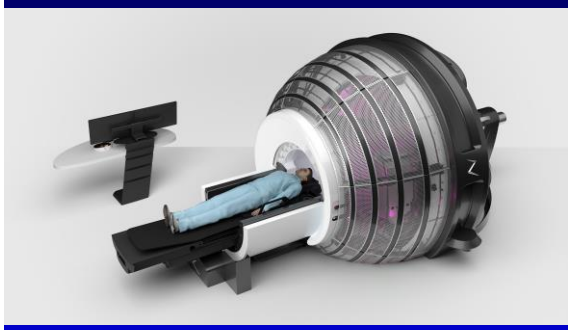
ZAP-X GYROSCOPIC RADIOSURGERY



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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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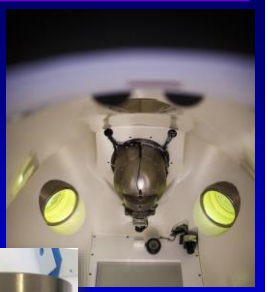
LINAC-BASED

- 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

Optimized Collimation

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



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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APPLICATIONS

Primary & metastatic brain tumors

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

Head & neck lesions

Cervical spine lesions

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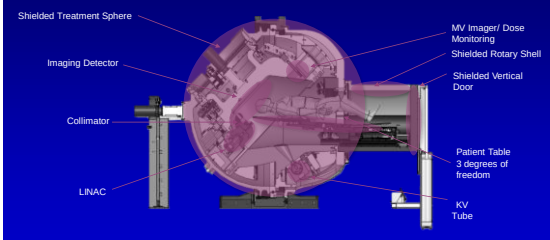

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EXOSKELETON

- 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

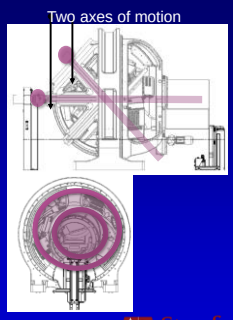

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IMAGE GUIDANCE

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

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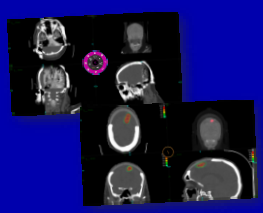
TREATMENT PLANNING

- 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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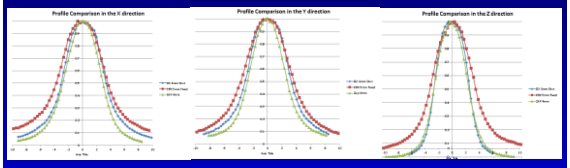
BEAM COMPARISON



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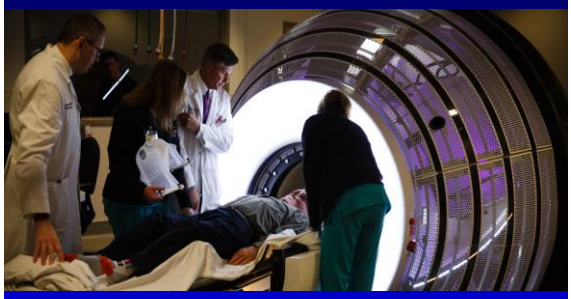

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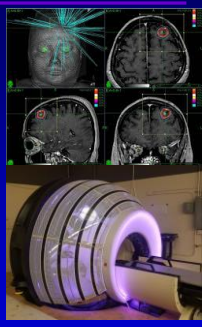
Radiomodulation

- 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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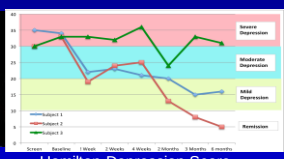
Cg25 Irradiation for Intractable Bipolar Disorder

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



Hamilton Depression Score

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The Future of Neurosurgery?

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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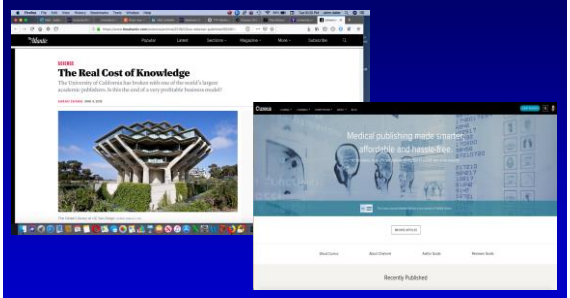
Cureus



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